Systematics of Peloridiidae (Insecta: Hemiptera: Coleorrhyncha) – an integrative approach

D i s s e r t a t i o n
zur Erlangung des akademischen Grades
d o c t o r r e r u m n a t u r a l i u m
(Dr. rer. nat.)
im Fach Biologie

eingereicht an der
Lebenswissenschaftlichen Fakultät
der Humboldt-Universität zu Berlin

von
Dipl. Biol. Viktor Hartung

Präsidentin der Humboldt-Universität zu Berlin
Prof. Dr.-Ing. Dr. Sabine Kunst

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Gutachter/innen: 1. Prof. Dr. Hannelore Hoch
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3. Prof. Dr. Gerhard Scholtz

Tag der mündlichen Prüfung: 25. Mai 2018

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Doctoral thesis

by
Viktor Hartung

To the memory of Viktor Fjodorov

– Schlimm genug! Wieder die alte Geschichte! Wenn man sich sein Haus fertiggebaut hat, merkt man, unversehens etwas dabei gelernt zu haben, das man schlechterdings hätte wissen *müssen*, bevor man zu bauen – anfing. Das ewige leidige »Zu spät!« – Die Melancholie alles *Fertigen*!...

Friedrich Nietzsche*, Jenseits von Gut und Böse,* 277.

1 Introduction

Current state of knowledge

The family Peloridiidae numbers at the moment only 37 species (Burckhardt, 2009; Burckhardt et al., 2011; Shcherbakov, 2014) of small (2-3 mm body length is typical), cryptically coloured insects (s. fig. 1). They are mostly found in bryophytes, quite unusual for herbivores (Gerson, 1982); this host plant association brought them their trivial name, the moss bugs. Representatives of the family inhabit temperate forests (e.g. the *Nothofagus* forests; Veblen et al., 1996) and fens of Australia, Lord Howe Island, New Caledonia, New Zealand and southern South America. The fact that all but one species are wingless (macropterous individuals rarely occur in the South American species *Peloridium hammoniorum*, although nobody yet really saw them flying) diminishes their dispersal capacities and makes them an often cited example of Gondwanan distribution (e.g. Grimaldi & Engel, 2005). Unconspicuous as hobbits, they are nevertheless important as a taxon of crucial position for the system of Hemiptera. Unfortunately, the regions and habitats where Peloridiidae occur are often not readily accessible and the small size and cryptic habits of the moss bugs make them rare in scientific collections – and information on behavior and ecology of the living animals is even rarer.

Figure 1. A female of the Chilean peloridiid *Idophysa chonos* on a liverwort (photo courtesy of Jürgen Deckert).

Hemiptera is the only hemimetabolan group among the “big five” of the megadiverse insect taxa (Rafael et al., 2009; Austin et al., 2004). It is certainly monophyletic, demonstrating such apomorphies as complete reduction of maxillar/labial palps and sucking mouthparts of characteristic structure (e.g. Grimaldi & Engel, 2006). Hemiptera themselves are divided into 4-5 subgroups, depending on the viewpoint of respective authors (s. below).

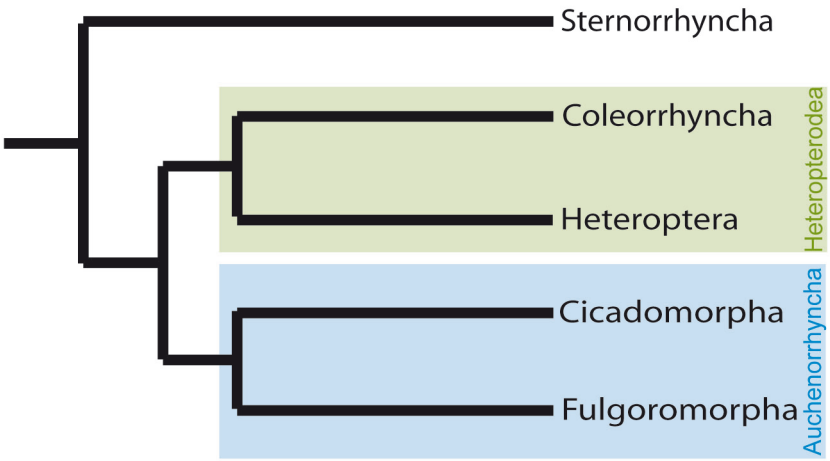

Figure 2. A cladogram of Hemiptera, after the phylogenetic hypothesis of Cryan & Urban (2012)

Sternorrhynha, with more than 10.000 described species (Strümpel, 1983), although this number is probably too conservative (Hodkinson and Casson, 1991), comprise jumping plant lice (Psylloidea), aphids (Aphidoidea), scale insects (Coccoidea) and whiteflies (Aleyrodoidea). A reduction of the claval region in the wings and the base of the rostrum located between or even behind the fore coxae (e.g. Hennig, 1981) are among the autapomorphies of the group whose monophyly is seldom questioned nowadays. Not so that of the next hemipteran subtaxon, Auchenorrhyncha: opinions differ here, some workers considering the group paraphyletic (e.g. Bourgoin & Campbell, 2002), whereas others presented evidence for their monophyly (e.g. Cryan & Urban, 2012) with such synapomorphies as aristate antennae and data of molecular phylogenetics. Two subtaxa of Auchenorrhyncha are generally recognized – Fulgoromorpha (planthoppers) with over 12.000 described species (Kunz, 2011; FLOW) and Cicadomorpha (leafhoppers, treehoppers, froghoppers, spittlebugs, cicadas) where at least 35.000 are known (Kunz, 2011). The third hemipteran subgroup is Heteroptera, or the true bugs. Its monophyly is unquestioned, corroborated by such apomorphies as a gula on the ventral side of the head, rendering the true bugs the only prognathous Hemiptera, or metathoracic and abdominal scent glands (Forero, 2008). True bugs are divided into seven subtaxa (Stys & Kerzhner, 1975; Schuh & Slater, 1995): Enicocephalomorpha, Dipsocoromorpha, Nepomorpha, Gerromorpha, Leptopodomorpha, Cimicomorpha and Pentatomomorpha. Heteroptera is also the largest hemipteran group: Henry (2009) lists almost 42.000 described species.

Peloridiidae is the only recent family of the last hemipteran subgroup, the Coleorrhyncha. However, coleorrhynchans are quite abundant (s. Popov & Shcherbakov, 1996 for a review) in the fossil record of Africa, Australia and Eurasia from Permian to Cretaceous and thus not limited to Gondwana. The modern moss bugs are therefore considered a relict group.

Controversies on the systematic position of Peloridiidae date as far back as the history of their study and concern mostly the question whether the group is more closely related to Heteroptera or Auchenorrhyncha. In the beginning, the heteropteran affinities were considered predominant. The type species of the family, *Peloridium hammoniorum*, was described by Gustav Breddin from material collected by a German expedition in Chile (Breddin, 1897). Breddin recognized the uniqueness of the species and erected a new family for it, suggesting relatedness to the family Ochteridae (Heteroptera: Nepomorpha). His opinion was on the whole shared by several other workers (Haglund, 1899; Horvath, 1899; Kirkaldy, 1906; Reuter, 1912).

However, this view was soon questioned by Myers & China (1929) after the first dissection study on a specimen of the Australian species *Hemiodoecus leai* China, 1924. They erected for the family a new series of "Homoptera" (a traditional grouping of Sterno- and Auchenorrhyncha that is now considered paraphyletic): the Coleorrhyncha. Evans, who in the next 40 years became the most active researcher of Peloridiidae, supported their view in his publications (Evans, 1938; 1963). Müller (1951), based on morphological features of symbiotic bacteria and their harbouring organs of the peloridiid *Hemiodoecellus fidelis* Evans, 1937, and China (1962), based on tegminal, wing and tarsal characters, even supported the inclusion of Peloridiidae within Auchenorrhyncha (China suggested the taxon "Peloridiidomorpha", analogous to Fulgoro- or Cicadomorpha).

With the emergence of phylogenetic systematics (Hennig, 1965), it did not last long until such a controversial group was analyzed with hennigian methods. Schlee (1969) was the first to apply them and found several synapomorphies supporting the sister-group relationship between Peloridiidae/Coleorrhyncha and Heteroptera; he coined the taxon name "Heteropteroidea" for this monophylum. His view and the new taxon name were fully adopted by Hennig himself (Hennig, 1981); "Heteropteroidea" was later emended to "Heteropterodea" (Zrzavy, 1992) to avoid confusion with a superfamily taxon. Cobben (1978, p. 190) called Schlee's synapomorphies of Heteropteroidea "superficial and probably not significant", without going much into detail or applying cladistic methodology to them, but most other workers accepted Schlee's view. D'Urso (1993) provided an additional synapomorphy for Heteropterodea by demonstrating similarities of the wing-coupling apparatus in Peloridiidae and Heteroptera in contrast to "Homoptera". In a recent work, Spangenberg et al. (2013) added fine details of head morphology that can be considered as synapomorphies of Heteropterodea: presence of certain muscles, structural details of salivary ducts and ganglia, mandibular sulcus and two reduction characters: absence of clasping organ in the labial groove and absence of cervical sclerites. Friedemann et al. (2014) used Peloridiidae in their morphology-based phylogenetic analysis of Acercaria and also found a sister-group relationship between moss bugs and Heteroptera, with such synapomorphies as absence of tegulae, presence of cephalic trichobothria, tubular labium with 4 segments and antennae with 4 or less segments.

As molecular phylogenetics became more and more common, its methods were also applied to Peloridiidae/Coleorrhyncha. Wheeler et al. (1993) provided the first study, where the authors combined morphological characters with sequences of 18S DNA to a large Heteroptera sample, one peloridiid, three Cicadomorpha and one Sternorrhyncha species and obtained support for Heteropterodea as monophylum. Campbell et al. (1995) also analyzed 18S DNA sequences, with much better sampling of Aucheno- and Sternorrhyncha and much poorer of Heteroptera, and also received support for the monophyly of Heteropterodea (that these authors call Prosorrhyncha, after

suggestion of Sorensen et al., 1995, that did not become universally accepted). Ouvrard et al. (2000) analyzed complete 18S DNA sequences and also received quite strong support for this grouping; later, Xie et al. (2008) made new alignments of complete 18S DNA sequences and also obtained monophyletic Heteropterodea (that they also call Prosorrhyncha). Cryan & Urban (2012) in their analysis of Hemiptera using 5 nuclear and 2 mitochondrial genes also received support for the monophylum of Peloridiidae + Heteroptera. Thus, the taxon Heteropterodea (or Prosorrhyncha) seemed well established by the mid-2000s and was adopted e.g. by Grimaldi & Engel in their influential *Evolution of the insects* (2005).

However, critique on the sister-group relationships between Heteroptera and Peloridiidae (or Coleorrhyncha) was voiced even on this background. The most persistant opponents were to be found among paleontologists. Thus, Popov & Shcherbakov (1996) provided an interesting discussion of Schlee's (1969) and Wootton's (1965) putative synapomorphies of Heteropterodea, demonstrating that at least some of those might be homoplasies or even symplesiomorphies. At the same time, Popov & Shcherbakov (1996), in their attempt to demonstrate that Coleorrhyncha are a Hemipteran lineage that originated from Auchenorrhyncha-like ancestors independently of Heteroptera, did not apply cladistics methodology consequently. They did not conduct a formal phylogenetic analysis with an exhaustive sample of outgroups, including representatives of Auchenorrhyncha and Heteroptera alike, and did not make explicit how they assessed polarities of character states, indicating only casually that they used the fossil coleorrhynchan subfamily Karabasiinae for that. Still, the idea that Coleorrhyncha might be closer to Auchenorrhyncha than to Heteroptera has become quite popular with paleontologists. Szwedo et al. (2011) support the idea that "Coleorrhyncha evolved in parallel to the true bugs (Heteroptera), acquiring some superficial similarities but retaining basic differences", although without undertaking an attempt to test this assumption in the phylogram they provide, concentrating only on the internal topology of their phylogenetic tree of Coleorrhyncha that was constructed without defining an outgroup. Dong et al. (2014) treat the relationships of Coleorrhyncha more carefully as "uncertain" and do employ outgroup comparison in their phylogenetic analysis of Coleorrhyncha, but without using any representatives of Heteroptera, thus making a validity test for Heteropterodea impossible.

Still, the notion that Peloridiidae/Coleorrhyncha might be closer related to Auchenorrhyncha or some of its subgroups received support from other studies in recent years. Cui et al. (2013) conducted a first phylogenetic study of Hemiptera with mitochondrial genomes and Peloridiidae were nested within Auchenorrhyncha in their analysis, Cicadomorpha being the sister group to Heteroptera. A year later, Misof et al. (2014) in their widely cited phylogenomic study of Insecta, applying hundreds of nuclear markers to three species of Auchenorrhyncha, 4 of Heteroptera and one Peloridiidae (*Xenophysella greensladeae* Burckhardt, 2009), obtained a sister-group relationship between Auchenorrhyncha and Peloridiidae in their phylogenetic reconstruction. Wang et al. (2015) in a mitogenomic analysis of Hemiptera obtained Fulgoromorpha + Coleorrhyncha and Cicadomorpha + Heteroptera as sister groups. However, Li et al. (2017) demonstrated that genomics data are sensitive to an appropriate choice of analysis methods: in their study of more than a hundred mitochondrial genomes of various Hemiptera and outgroup taxa a sister-group relationship between Peloridiidae and Heteroptera emerged as soon as taxa with anomaly high substitution rate were omitted and appropriate sequence substitution models applied. But in the same year the study by Yoshizawa et al. (2017) demonstrated that wing-base sclerites of Peloridiidae (more exactly,

macroptreous specimen of *Peloridium hammoniorum*) and Auchenorrhyncha share a potential synapomorphy – although after addition of this character to the matrix from Friedemann et al. (2014) the topology of the tree did not change and Peloridiidae remained the sister group to Heteroptera, even if with less statistical support. At the same time, Yoshizawa et al. (2017) could demonstrate that *P. hammoniorum* do possess tegulae, thus omitting the character "tegulae absent" from the list of potential synapomorphies of Heteropterodea provided by Friedemann et al. (2014).

So, although the morphological evidence for the sister-group relationships between Peloridiidae/Coleorrhyncha and Heteroptera is quite good, some uncertainties still do exist and new molecular data delivered contradictory cues and have made affinities between Auchenorrhyncha and Coleorrhyncha somewhat more plausible. A test of sister-group relationships of Peloridiidae with new character sets would be highly welcome here.

Intrafamiliar systematics of Peloridiidae

The inner groupings of the family Peloridiidae have been discussed even before the emergence of phylogenetic systematics (e.g. Woodward, 1956; China, 1962; Evans, 1967) – with sometimes quite contradictory conclusions, although most authors agreed that Australian and New Zealand species represent coherent groupings and that Australian representatives are closer related to South American ones than to those from New Zealand. The first attempt to test these hypotheses with cladistic methodology came from Popov & Shcherbakov (1996), who used fossils of Coleorrhyncha: Karabasiinae to determine polarity of their 26 morphological characters of different genera they mostly drew from literature (fig. 3). They came to the conclusion that genera from Australia (including Lord Howe Island), South America and New Zealand + New Caledonia form three monophyletic groups within the family, NZ + NC clade branching off most basally and being sister to Australia + South America clade. This branching pattern corresponds well with the geological history of Gondwana (Crook, 1981), although the robustness of the analysis is impaired by its heavy reliance on literature information and limitation to genus level.

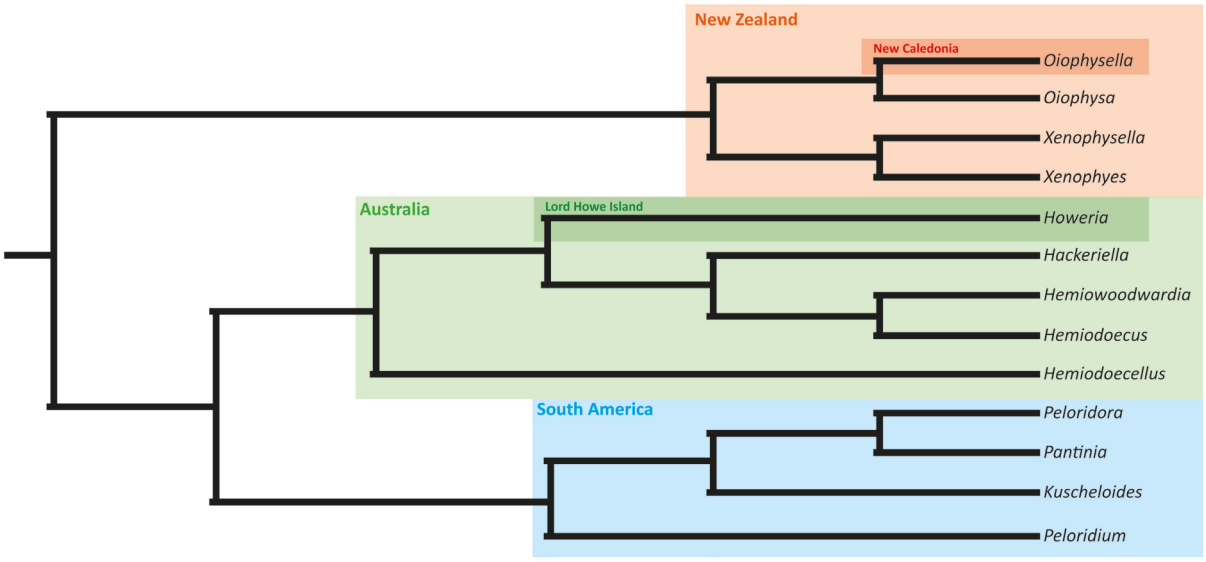

Figure 3. Cladogram of Peloridiidae after Popov & Shcherbakov (1996)

Burckhardt (2009) analyzed all 32 Peloridiidae species that were known at this time, applying 32 morphological characters to them. He arrived at results quite similar to those of Popov & Shcherbakov (1996), as shown in fig. 4:

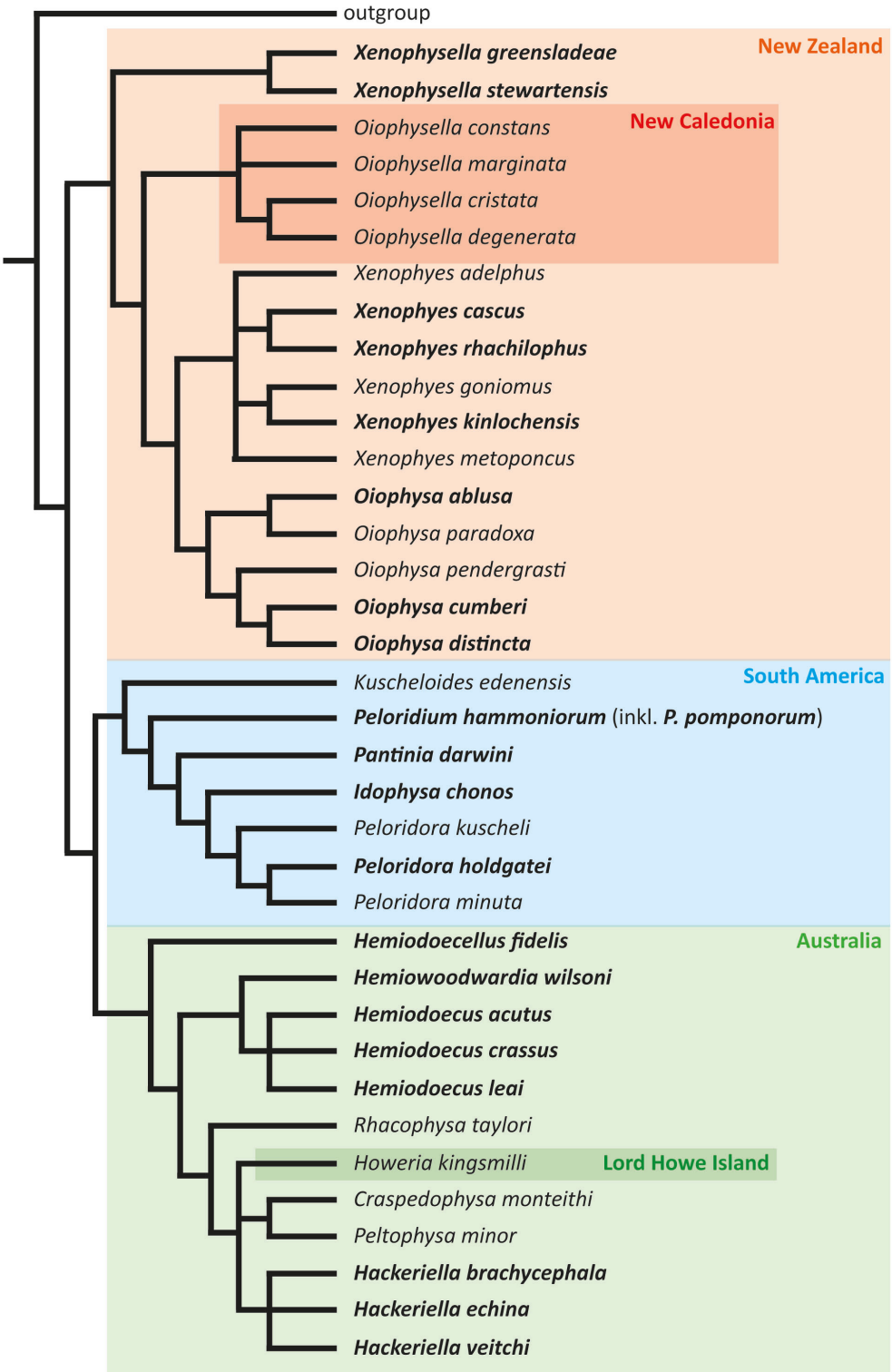

Figure 4. Cladogram of Peloridiidae after Burckhardt (2009), completed by data of Larivière et al. (2011). *Peloridium pomponorum*, described by Shcherbakov (2014), is included within *P. hammoniorum*. Species used in the present study are highlighted in bold.

Here again, New Zealand species form a paraphyletic group with New Caledonian representatives nested in it. Together they form a monophylum that is on the basalmost branch of the phylogenetic tree, being a sister group to the clade formed by Australian + South American species, every of those also monophyletic and sister to each other. Only finer details differ, as e. g. basal position of the genus *Xenophysella* in New Zealand/New Caledonia clade (quite derived in Popov & Shcherbakov's view), or the genus *Peloridium* branching off not so basally in South American clade (on the basalmost branch in Popov & Shcherbakov, 1996), or the Lord Howe representative *Howeria* nested within the group of taxa from Queensland or Northern New South Wales (Burckhardt, 2009), being the sister group to all Australian representatives except *Hemiodoecellus* in the tree of Popov & Shcherbakov (1996). However, an important shortcoming of Burckhardt's analysis is the outgroup comparison. Due to the fact that many characters of Peloridiidae are not present in potential sister groups, Burckhardt (2009) constructed an artificical outgroup where most characters were set as 0 and some as missing.

Molecular analyses do not face the problem of missing characters states in outgroups, but the difficulty here is the time- and resource-consuming collecting of enough specimens of satisfying quality from a large species sample (as mentioned before, habitats of Peloridiidae are often not so easily accessible) along with the sequencing effort. Thus, Wheeler et al. (1993) and Campbell et al. (1995) only used one species (Australian *Hemiodoecus leai*), Misof et al. (2014) in their phylogemonic study also only one (New Zealand *Xenophysella greensladeae*). Ouvrard et al. (2000) and Xie et al. (2008) used two Australian species (*Hackeriella veitchi* and *Hemiowoodwardia wilsoni*), Cui et al. (2013) also two (*H. veitchi* and New Zealand *Xenophyes cascus*) and Cryan & Urban (2012) two species as well (*X. cascus* and South American *Peloridora minuta*). Sampling of Li et al. (2017) with 5 species from 3 different continents is the largest peloridiid sampling in a molecular study to date (*H. veitchi, H. leai, P. minuta, X. cascus* and South American *P. hammoniorum*), but still quite poor compared to morphology-based studies by Popov & Shcherbakov (1996) and Burckhardt (2009).

Thus, up to this date there is no published phylogenetic analysis of the family that would involve both cladistic methodology and a sufficient sampling of species from different regions that would allow inference of intrafamiliar structure of Peloridiidae.

Peloridiidae biology

In the first decades since their discovery, biology, ecology and life history of Peloridiidae remained unknown. Reseachers depended on just a few specimens that were collected occasionally. Only in 1936-37 it was discovered that bryophytes are the host plants of the insects (Helmsing & China, 1937; Evans, 1989). Helmsing and China (l. c.) also provided the first account on ecology and behavior of a peloridiid (the Australian species *Hackeriella veitchi* (Hacker), 1932). They observed the insects mating and could keep them alive in the laboratory for ten months, but were not successful in observing the insects actually feeding on moss. Nevertheless, Helmsing & China (1937) recorded the first moss species harbouring the insects and thus most likely their host plant: *Papillaria crocea* (Hampe) A.Jaeger, cited by Helmsing & China as *P. kermadecensis* (MÜLL. HALL.) A. JAEGER (a name later degraded to a synonym, Streimann, 2012). They also were able to suggest hypotheses

concerning seasonality and time of development of the species and described fungi picnidia of *Uncinula* group on the insect's body surface. Later, several other findings of bryophyte species that harbour Peloridiidae were published (summarized in table 5, Discussion section 4.1.). However, until now nobody studied the host plant affinities of the family systematically.

Apart from sparse notes on the host plants, involvement in phylogenetic analyses and traditional morphologic descriptions, few biological studies have been conducted on Peloridiidae. Müller (1951) was the first to study bacterial symbionts of Peloridiidae morphologically and considered that their structure suggests affinities to Fulgoromorpha. Pendergrast (1962) conducted the first study of internal anatomy of Peloridiidae. Estévez & de Remes Lenicov (1989) were able to keep several dozens of individuals of *Peloridium hammoniorum* in the laboratory, observe their locomotion, feeding (on *Polytrichum strictum* MENZ. ex BRID.), defecation and even some fine details of morphology such as antennal sensilla or surface secretion. Hoch et al. (2006) studied vibrational communication in *Hackeriella veitchi*, and Burrows et al. (2007) described jumping behavior in the same species. Brożek (2007) provided the first scanning electron microscopic study on the family (a brief account on labial sensilla of *Xenophyes cascus*), and some additional SEM data were provided by Spangenberg et al. (2013), whose main focus was on inner head morphology of *Hackeriella veitchi*. These few articles comprised the only pieces of information on biology, physiology, ecology and behavior of Peloridiidae that were known before the start of the present study. The results by Küchler et al. (2013), Grozeva et al. (2014), Santos-Garcia et al. (2014) and Kuznetsova et al. (2015) were obtained under participation of the author of the present study i.a. on the specimens collected for it and are considered in the Discussion section.

Integrative approach

Several years ago, the term "integrative taxonomy" emerged in literature (e.g. Padial et al., 2010). Dayrat (2005), one of its first proponents, defines it as "the science that aims to delimit the units of life's diversity from multiple and complementary perspectives (phylogeography, comparative morphology, population genetics, ecology, development, behaviour, etc.)." Although a new term, conceptionally it is very similar to "biotaxonomy", or biosystematics, that was defined by Claridge (2005) as "all sorts of studies which might illuminate the genetic, and therefore specific, status of groups of related organisms". Drosopoulos (2005) traces this approach as far back as into 1940s, and Wake (2003) demonstrates that e.g. Charles Darwin can be called "integrative biologist" with full justification. Hovewer, when the cited authors speak of integrative taxonomy or biosystematics, although they mention "groups" or "units of life's diversity", they mostly bear only species in mind. At the same time, clues from different biological disciplines can be used in systematics above species level. For instance, fine morphological features visible in scanning electron microscopy are involved here quite commonly. Classical morphology often lacks power when dealing with organisms of the Peloridiidae size class. Electron microscopy can offer an instrument that can help with this difficulties and has been successfully employed in systematics of many other Hemiptera and Insecta in general, although not yet for Peloridiidae. One can mention such well-known character complexes as pretarsal structures (e.g. Schuh, 1976; Friedemann et al., 2014), mouthparts and their sensilla (e.g. Cobben, 1978; Brożek & Bourgoin, 2013), or antennae (e.g. Marshall & Lewis, 1971; Meinecke, 1975;

Schambaugh et al., 1978) – but also structure of the surface (e.g. Dietrich, 1989) or integumental glands (Foldi & Cassier, 1985; Foldi, 1991). Acoustic signals can be very variable even in closely related species (*especially* in closely related species), but can nevertheless be applied in systematics of higher taxa as well (e. g. Tishechkin, 2005). The last but not least, host plant affinities can also provide valuable clues on systematics of herbivore insects (e. g. Mitter et al., 1991). But changes of intraspecific signal mechanisms and shifts of ecological niches are more than just characters for phylogenetic analysis – they are among the evolutionary mechanisms that lead to speciation and expansion of biodiversity. A study of these character complexes can help inferring the system of organisms as living beings, and in the special case of Peloridiidae possibly shed light on the origin of their peculiar lifestyle, behavior and derived morphological traits.

Thus, the primary goals of the study presented here were:

1) to generate and synthesize information on the biology of the Peloridiidae, based on field observations and laboratory studies, pertaining to host plant preferences, behavior, intraspecific communication, fine morphology and other previously insufficiently studied aspects, such as cytogenetics and symbiont composition

2) to test the existing hypotheses on the phylogenetic relationships within the Peloridiidae, as well as to other taxa within the Hemiptera.

2 Materials and methods

2.1 Specimen origins and field collections

Peloridiidae specimens were collected 2009-2014 on different localities in Australia, New Zealand and Chile, based on the literature data (e.g. Burckhardt, 2009). For analysis of host plant preferences, bryophyte species were collected separately in a given locality. The species (along with the general features of the locality) were documented in field notes and photographically with Olympus SP 500UZ digital camera and in most cases a voucher specimen of the bryophyte species was taken for later identification. Sometimes identification was possible on the spot; in any case, it was conducted later in the lab by means of photos and herbarium samples. Collected samples of bryophytes were analyzed in Berlese funnels (fig. 5. B-C); if the bryophyte material was present in an amount more than would fit into a funnel, it was concentrated with a sifter (fig. 5. A) and the sifted material was then analyzed in the funnel. Funnels with the grid diameter of ca. 25 cm and with the bulb-to-grid distance of 4-8 cm were used. The extraction lasted 8-36 hours, depending on the moisture level of the sample, until it was completely dry. Sometimes the funnels were covered in plastic bags with ventilation orifices, as this proved to be effective for extracting peloridiids under the field conditions of the study. The Peloridiidae specimens emerging from those analyses were either stored in 100% alcohol immediately or kept alive as long as possible, for observations of the behavior and acoustic recordings – in small plastic vials with several specimens of their native bryophytes or, if those were not available, with bryophytes that could be obtained in Berlin.

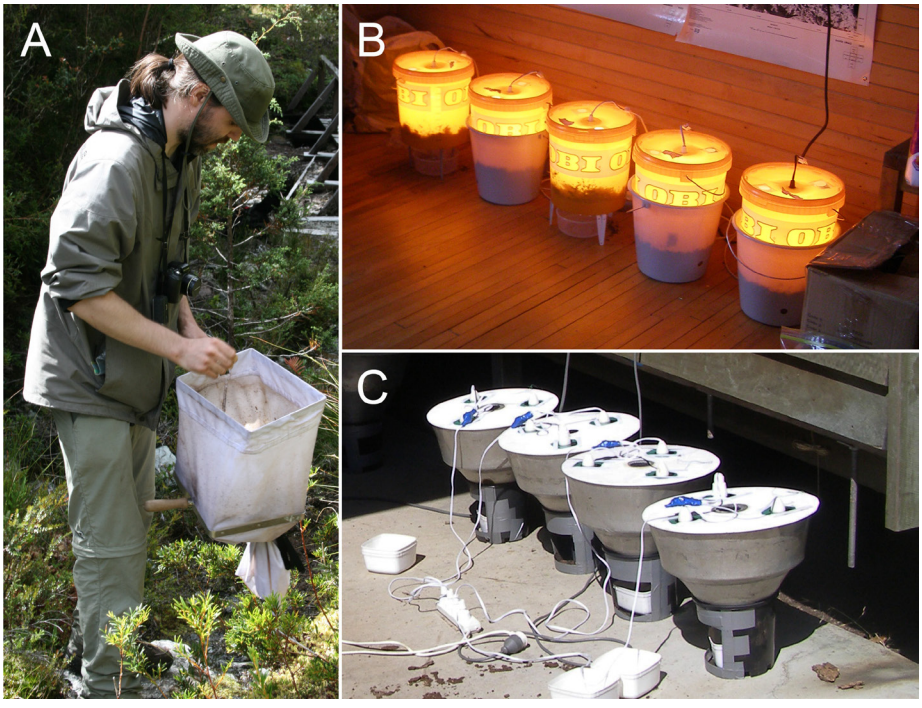

Figure 5. Collecting technique and equipment. A – the author sifting bryophytes in Chile (photo courtesy of Roman Rakitov); B – Berlese funnels used in the collecting trip to Chile 2014; C – Berlese funnels of the model used on the collecting trip to Australia and New Zealand, 2009-2010.

Supplement 1. gives a detailed list of localities with coordinates, bryophyte species analyzed, peloridiid species obtained and other details. Collections in Australia were done under permits № WITK06355209 (Queensland), S13005 (New South Wales), 10005138 (Victoria) and FA10018 (Tasmania); in New Zealand under WE-26346-RES; in Chile under a permit issued by CONAF.

In addition to the specimens obtained during the collecting trips to Australia, New Zealand and Chile, some living specimens of *Xenophyes cascus* and *Oiophysa cumberi* collected by George Gibbs (Victoria University, Wellington) in December 2011, March 2012 and January 2013 in Otaki forks (Tararua Forest Park, North Island, New Zealand; s. Supplement 1.) were used for recordings of their acoustic signals and observations of their feeding and behaviour. Some specimens of *Hackeriella veitchi* collected by Geoff Monteith in 2007 in Springbrook National Park, Queensland, Australia, were used for scanning electron microscopy.

Most specimens of Hemiptera that were used as outgroup taxa for the phylogenetic analysis of fine morphological traits were obtained by the author on various occasions in Germany, Poland and Italy in 2012-2016. They were fixed in 70-100% alcohol or dry mounted; no specific details on collections are given, since the specimens belong to common species that are easily available in those countries. Specimens of *Ceratocombus* (Heteroptera: Dipsocoromorpha) were kindly provided by Petr Bañař (Moravské Zemské Muzeum, Brno, Czech Republic) from collections made by Petr Bañař and Luboš Dembický 2009-2013 in Cameron Highlands, Malaysia. Two specimens of *Issus coleoptratus* (collected 1978 in Potsdam, Germany, and 1921 in South Tyrol, Italy) were kindly provided by Jürgen Deckert.

2.2 Laboratory observations

Living specimens of several Peloridiidae species were observed under dissecting microscope Leica® MZ6; photo- and videodocumentation was performed together with Jürgen Deckert using Canon E0S 400D camera, MP-E 65mm lense an the ringflash Macro Ring Lite MR-14EX. Additional photos were made with Leica® DFC 490 digital camera mounted on a Leica® Z16 ApoA and aligned with Automontage® software version 5.03.0061 (Syncroscopy). For tests of jumping behavior (conducted together with Roland Mühlethaler), 8 specimens of *Xenophyes cascus* and one *Oiophysa cumberi* were exposed to strong light form several coldlight sources and tablelamps and delicately stimulated with a paintbrush, as described by Burrows et al. (2007).

2.3 Bryophyte identification and nomenclature, data processing

Bryophytes were identified with the following literature:

- Leon & Olivan (2014) – liverworts, Chile
- Larrain (2007) – mosses, Chile

- Allison & Child (1975) – liverworts, New Zealand
- Beever et al. (1992) – mosses, New Zealand

These identifications were controlled and corrected by Prof. Dr. Harald Kürschner, Systematic Botany, Free University Berlin. Most of the identifications of the Australian bryophytes were conducted by the late Dr. Elizabeth Brown, then a curator at the National Herbarium in Sydney.

Systematics of mosses above the genus level follows the *Bryophyte biology* by Shaw & Goffinet (2000) and Goffinet & Buck who maintain a website with an up-to-date version of the system. Species names are given in accordance with Beever et al. (1992), but wherever available, more recent literature was consulted – e.g. Kruijer (2002) for Hypopterygiaceae; Huttunen et al. (2008) for Meteoriaceae; Pokorny et al. (2011) for Daltoniaceae; Ireland et al. (2017) and Fife (2012) for Sematophyllaceae.

Systematics of liverworts and the species names nomenclature follows Glenny (1998) or Allison & Child (1975). Some groupings are treated differently based on current literature. Thus, the family Anastrophyllaceae that was established recently by Söderström et al. (2010) is recognized in the present study, too; nomenclature of *Apometzgeria* follows Fuselier et al. (2011).

To summarize the host plant specificity of peloridiid species in a simple measure, a specificity index *S* was developed. It is an index calculated according to the formula $S = (N - h)/N$, where N is the total number of all bryophyte species that were analyzed in all localities where a particular peloridiid species was obtained, and h the total number of all host species. For details on calculations s. the Supplement 2.

2.4 Scanning electron microscopy

2.4.1 Specimen preparation, equipment and settings

All species of Peloridiidae possess surface secretion that covers the whole body of the insect and obscures most of the fine morphological structures (China, 1962; Estévez & de Remes Lenicov, 1989; Hartung et al., 2016). The secretion must be removed before scanning electron microscopy; in the present study it was achieved by an overnight incubation in ethyl acetate that makes the surface covering more brittle and easy to remove manually with fine paintbrush and needles. Several of the outgroup taxa (e.g. *Issus coleoptratus, Laodelphax striatella, Psylla alni*) carry waxy secretions on some regions of the body, along with Peloridiidae whose abdominal terga, ventral sides of tegmina and some other body parts are also covered with wax. This secretion was removed by incubation in chloroform (mostly overnight, sometimes up to 3 days long). Cicadellidae specimens normally carry a covering of brochosomes, nanoscopic polymere particles that are built in Malpighian tubules and dispensed by the insect on its body surface (Rakitov, 2002). These were removed by an overnight incubation in commercially available water-soluble resin that was detached manually after polymerization together with brochosomes. Some regions carrying morphological structures of particular interest, as tarsi or labium tip, were cleaned by overnight incubation in a commercial

dishwashing detergent, rinsing in tap water and gentle manual application of a fine paintbrush. In order to inflate the membranous structures of tarsi (such as arolia or pulvilli), the legs were separated from the rest of the body, incubated overnight in KOH, then overnight in distilled water, then transferred through a series of ascending alcohol concentrations to 100% alcohol and critical point-dried.

Critical-point drying was performed on BAL-TEC CPD 030, sputtercoating on Quorum SC7640 and Quorum Q150RS (the layer thickness that had to be applied varied very much even between different Peloridiidae specimens and is not specified here). Scanning electron microscopy was performed on a Zeiss EVO LS10.

2.4.2 Terminology

Sensilla terminology. Classification and typology of sensilla in insects is quite complicated and no uniform way of describing them exists. This is not least due to different requirements that are posed by physiologists who are mostly interested in function and systematists who emphasize characters that vary between taxa. The functional classification of Zacharuk (1980) and Altner & Prillinger (1980) discerns e.g. between sensilla with one terminal pore, with many pores and without pores. Then, there is the traditional classification into trichoid, chaetic, basiconic, coeloconic, placoid etc. sensilla, which dates quite far back and was already established at the time of Snodgrass (1926). It groups sensilla according to their external appearance and is therefore still widely used by taxonomists, but has a number of limitations. First, as already Altner & Prillinger (1980) noticed, sensilla that can be put to the same morphological category often differ in their fine structure and function. Second, homologous sensilla and functionally uniform sensilla in different species may be quite different in their external appearance and thus attributable to different morphological categories championed by Snodgrass (1926). For instance, the Oriental cercopid genera *Baibarana* and *Temogmometopius* possess a slim basiconic sensillum on the tip of the pedicel (Liang et al., 2006), whereas in several Australian genera the basiconic sensillum has a very broad basis, occupying almost all of the pedicel tip (Liang & Fletcher, 2002). In the genus *Anyllis* from the closely related family Aphrophoridae, the pedicel tip is occupied by a large placoid sensillum (Liang et al., 2005). Despite the different morphological categorization, in all these cases the surface of the sensilla is finely porose, indicating the same olfactory function and their location is very similar so that they can be considered homologous. Third, even if sensilla can be attributed to the same morphological and functional category, they still might be very variable, causing authors to invent new categories for describing them (e.g. Brożek & Bourgoin, 2013, who in their description of fulgoromorphan mouthparts introduce cupola-shaped sensilla, clavate sensilla, different peg sensilla which all would fit into the broad category “basiconic sensilla”). Thus, the limitations of the existing classifications are obvious and overcoming them is beyond the scope of this work. However, some adjustments needed to be done to the existing classifications in order to deal with such diverse taxa as Peloridiidae and the outgroups used in this study.

Some teratological experiments (Ikeda-Kikue & Numata, 1991) demonstrate that the functional specialization of sensilla is more important for the sensory architecture of the organisms than the homological relations: bugs with the amputated terminal antennal flagellomere developed enlarged subterminal segments with sensillar configuration normally not typical for them, but for the terminal segment of the antenna. Different species of Cercopidae and Aphrophoridae have sensilla of the same function on the pedicel, but the fine morphology may differ – placoid or basiconic sensilla are possible, or some intermediate variants (Liang et al., 2005; 2006; Liang & Fletcher, 2002). Therefore, when comparing higher taxa, more effort was given to identify the possible function of the sensilla. On finer scale, within a higher taxon, fine morphological details of the sensilla (such as those differentiated by Snodgrass, 1926, or Brożek & Bourgoin, 2013) were considered. Thus, the sensillar classification used in the present study had to be a combination of the function-oriented approach of physiologists as Altner & Prillinger (1980) and traditional classifications.

The function of the sensillum cannot always be identified with certainty from external appearance alone, although in many cases it can. A sensillum with a flexible socket always has mechanosensitive functions, one with numerous fine pores on the surface – olfactory, one with a terminal pore – gustatory, although in all these cases additional functions are possible (Altner & Prillinger, 1980; Zacharuk, 1980). Complications are caused by cases when no special pores or sockets can be seen – such sensilla might be thermo-and hygroreceptors (Altner & Prillinger, 1980) or have other functions. Sometimes fine pores in the surface of olfactory sensilla are not visible in regular SEM. Still, when describing a sensillum, it was first attempted to identify its possible function.

Traditional morphological typology was applied to description of sensilla after the functional assignment has been made. However, several adjustments had to be done. For instance, sensilla chaetica are not distinguished in the present study from sensilla trichodea, since even Snodgrass (1926) says that “sensilla chaetica are separated from the tactile hairs of the trichodea type only by the more spine-like or bristle-like character of the external parts, but the distinction is artificial and unnecessary…” (Snodgrass, 1926, p. 42). Likewise, Snodgrass points out in the same publication (p.43) that “there is no sharply dividing line between sensilla trichodea and sensilla basiconica”. Still, this differentiation was useful in the present study. Here, all sensilla with a socket were designated sensilla trichodea, all those without – sensilla basiconica. Not the other way, since a moveable socket puts the seta closer to the original cuticular hair than a structure without a socket; socket indicates ability to move (and in case of sensilla mechanosensitivity). Additional descriptive notations (such as “peg-like”, “cupola-shaped” etc.) were avoided whenever possible and only numbers were given to different classes of sensilla, if e.g. basiconic sensilla in a species can be divided into more than one class.

Third, only a flexible socket was called a socket in the present study, in contrast to many examples in literature where “inflexible sockets” are mentioned. Since a socket is an opening or a joint where a structure fits in, “inflexible socket” was considered a *contradictio in adiecto*.

Labium orientation. The labium of Hemiptera poses quite a few obstacles when a precise topological indication of its structures is concerned. It has the form of a tube with a groove on one side that encloses the mandibles and maxillae. Ontogenetically, the groove is located anteriorly; at the same time in the living animal, since the labium in most cases is carried reflected back along the body, the

groove is located ventrally. When discussing the figures of sensilla on the labium tip, the most convenient way to do this is to put the labium tip surface in the figure with the groove opening above, which seduces quite a few authors into calling that part “dorsal”, which it is in no way. It would be possible to select one way of naming the labium sides from the three mentioned, but that would lead to conflicts e.g. when discussing pictures made from different angles (imagine e.g. calling the upper region in the plate figures 14A, 15 and 16 “ventral”). For these reasons, in this study the terms “dorsal”, “ventral”, “anterior” or “posterior” are omitted altogether when speaking of labium. Instead, “sutural” is introduced as a term referring to the side of the labium where the groove is located, and “antisutural” as the term referring to the opposite side of the labium.

2.5 Intraspecific communication

Acoustic signals of Peloridiidae were recorded with the Polytec PDV100 vibrometer and a Roland digital recorder (sampling rate: 44100 Hz, bit depth: 16 bit). Recordings were made in closed plastic vials with wet bryophytes (details vary with recording and are given specifically to each) with the peloridiid specimens sitting on them. The laser beam of the vibrometer was directed at a small piece of reflector foil glued to the stem of the bryophyte where the specimen(s) was/were sitting.

In case of one species (*Oiophysa cumberi*), only two specimens were available (male and female), and signals were recorded only when both of them were together. In other species (New Zealand *Xenophyes cascus*, South American *Peloridium hammoniorum* and *P. pomponorum*), also only recordings of single male + single female were chosen, to keep the recording context uniform. The calls that were produced with this constellation in those species were essentially similar to those recorded with isolated males, and isolated females never produced any calls. The recordings used in the present study are listed below:

> *Oiophysa cumberi*. Male and female, collected by George Gibbs in Tararua Forest Park (North Island, New Zealand) in January 2013. Specimens kept in a small (ca. 7x7x4 cm) closed plastic dish on a mixture of their native mosses (mostly *Ptychomnion aciculare*) and a little of the fresh *Bryum bicolor* from Berlin; mosses were wet. Recorded in the dark acoustics chamber (a separate soundproof compartment) with the door open (closed door seemed to cause a rise in the abmient temperature). Vibrometer settings: Velo: 20, LP: 5, HP: Y. The laser beam was sent through the plastic lid of the dish. Recorded at room temperature on 12.02.2013, start at 12:44, first hour used in the analysis.
>
> *Xenophyes cascus*. Male and female, collected by George Gibbs in Tararua Forest Park (North Island, New Zealand) in April 2012. Specimens kept in a closed plastic dish on native moss (mostly *P. aciculare*); laser beam sent through the closed lid. Recorded in the dark acoustics chamber with the door open. Vibrometer settings: Velo: 100, LP: 22 und HP: Y. Recorded at room temperature on 11.05.2012, starting at 13:03, second hour used in the analysis.

Peloridium hammoniorum. Male and female, collected by the author at Estacion Biologica Senda Darwin (Ancud, Isla Grande de Chiloé, Region X, Los Lagos, Chile) on 07.02.2014, on *Polytrichadelphus magellanus*. Specimens kept in a closed plastic dish on native *P. magellanus*; laser beam sent through the closed lid. Recorded in the dark acoustics chamber with the door closed. Vibrometer settings: Velo: 20, LP: 22, HP: Y. Recorded at room temperature on 02.04.2014, starting at 11:47, the first hour and a half used in the analysis.

Peloridium pomponorum. Male and female, collected by the author at Estacion Biologica Senda Darwin (Ancud, Isla Grande de Chiloé, Region X, Los Lagos, Chile) on *Sphagnum falcatulum*. Specimens kept in a closed plastic dish on native S. falcatulum and some *Sphagnum* from Berlin. Recorded in the dark acoustics chamber with the door closed. Vibrometer settings: Velo: 20, LP: 22, HP: Y. Recorded at room temperature on 06.05.2014, starting at 10:45, an hour and the half (from the 38th minute of the recording on) used in the analysis.

Other calls of the species above were sometimes consulted when estimating some parameters of the signals. However, the parameters used for systematic comparison during the present study (length of the echeme, pulse frequency, number of pulses per echeme, fundamental frequency of the vibration) were found to be very similar in other recordings of the respective species, therefore no attempt was made to include more recordings in the present study.

In addition, a recording of the Australian species *Hackeriella veitchi* produced by Hoch et al. (2006) was analyzed for the purposes of comparison with the newly recorded signals. This earlier recording was produced not with a vibrometer, but instead by the magnetodynamic system by Strübing & Rollenhagen (1988).

Oscillograms were analyzed with Audacity 2.1.3® recording and editing software. Ca. 10 echemes of the same type were analyzed and following parameters (if applicable) estimated on the spectrogram built with Raven Lite 2.0 (Cornell Lab of Ornithology):

- duration, sec.
- pulse frequency (the number of pulses on a randomly chosen part of echeme divided by the time), Hz
- number of pulses (if this number did not exceed several hundreds)
- dominant fundamental frequency range, Hz

Images from Audacity® and Raven Lite 2.0 were enhanced with Adobe® Photoshop® CS5.

2.6 Phylogenetic analysis

The outgroup taxa were chosen to represent all three large groups of Hemiptera except Coleorrhyncha, and a representative sample of their subgroups (s. fig. 2.):

- *Psylla alni* (Linné, 1758) (Sternorrhyncha: Psylloidea)

- *Cercopis sanguinolenta* (Scopoli, 1763) (Auchenorrhyncha: Cicadomorpha: Cercopoidea)
- *Cicadella viridis* (Linné, 1758) (Auchenorrhyncha: Cicadomorpha: Membracoidea)
- *Laodelphax striatella* (Fallén, 1826) (Auchenorrhyncha: Fulgoromorpha: Delphacidae)
- *Issus coleoptratus* (Fabricius, 1781) (Auchenorrhyncha: Fulgoromorpha: Issidae)
- *Ceratocombus* sp. (Heteroptera: Dipsocoromorpha)
- *Saldula saltatoria* (Linné, 1758) (Heteroptera: Leptopodomorpha)
- *Corythucha ciliata* (Say, 1832) (Heteroptera: Cimicomorpha)
- *Pyrrhocoris apterus* (Linné, 1758) (Heteroptera: Pentatomomorpha)

Character matrix (93 morphological characters established with scanning electron microscopy) was prepared with WinClada 1.00.08 (Nixon, 1999). Phylogenetic analysis was performed with the freely distributed TNT program (Goloboff et al., 2008), one of the most efficient packages utilizing maximum parsimony methods. Characters were unweighted and non-additive. Traditional search was performed with default settings (Wagner trees, 1 random tree, 10 replications, TBR (tree bisection reconnection) swapping algorithm, 10 trees to save per replication). Among the trees derived, strict or majority rule (cut-off 50) consensus was calculated. Bremer support values were counted by TBR from existing trees, retaining trees suboptimal by 20 steps. Images provided by TNT were enhanced using Adobe® Illustrator® CS5 and Adobe® Photoshop® CS4 and CS5.

3 Results

3.1 Observations on living Peloridiidae

Figure 6. A specimen of *Hackeriella veitchi* feeding on a moss from Germany (*Brachythecium rutabulum*); scale bar: 500 µm

Following species were observed feeding in laboratory under a dissecting microscope:

- *Hackeriella brachycephala,* on native *Dicranoloma* species
- *Hackeriella veitchi,* on *Brachythecium rutabulum* from Germany (s. fig. 6.)
- *Oiophysa cumberi,* on *Bryum bicolor* from Germany
- *Pantinia darwini,* on native *Arbusculohypopterygium arbuscula*
- *Peloridium,* on native *Sphagnum* and *Polytrichadelphus magellanus* and a *Polytrychum* sp. from Germany
- *Xenophyes cascus,* on native *Wijkia extenuata, Ptychomnion aciculare, Hymenophyton* sp., *Plagiochila* sp. and *Bryum bicolor* from Germany

When feeding, insects mostly inserted their stylets into the stem of the bryophyte; sometimes (more common among larvae) into the conducting strand ("nerve") of a "leaf". The insertion was quite deep – at one occasion it could be estimated as at least the tarsus length of the animal (ca. 200 µm), on another the mouthparts reached the depth equal to ca. one third of the stem thickness. Feeding animals would leave the spot very reluctantly and needed up to 30 seconds to extract the mouthparts from the plant, an observation which is consistant with the immersion depth of the stylets during feeding.

When fresh animals were brought into the laboratory and offered both their native host plants and fresh German bryophytes, initially they preferred the native species, even when those started to lose turgor and become mouldy. However, after the dessication and fungal infestation on those reached certain level, Peloridiidae would readily change to the fresh bryophytes that could be obtained in Berlin. On those, they could be kept up to 9 months. Copulations were observed (although becoming rarer with time and completely disappearing after certain period) as well as successful imaginal moultings and one or two egg depositions, but no newly hatched specimens.

Peloridiidae were observed to prefer moist and avoid dry and well-lit environments. They were repeatedly observed feeding (or just sitting) on water-soaked plants, themselves submerged in water, without any attempts to come to the surface for long periods of time. However, as soon as the environment became drier, they would stop feeding and begin to move, trying to find a more humid and/or darker spot. This behavior was used for stimulating Peloridiidae specimens to jump (s. Burrows et al., 2007, and below).

A peculiar behavior was observed in several Peloridiidae species (*Hackeriella veitchi* from Australia and *Peloridum hammoniorum* and *P. pomponorum* from Chile): males riding on the back of their conspecifics (mostly females, but not exclusively); s. fig. 7.

Figure 7. Peloridiidae specimens riding on each other's back. A – *Hackeriella veitchi*, two males. B – *Peloridum hammoniorum*, male on a female (photos courtesy of Jürgen Deckert).

This behavior mostly occurred in a courtship context, for instance, male *Peloridium* "riders" were often observed producing acoustic signals (s. below). However, riding on the back of a female, let alone a male or a larva, did not necessarily lead the male to copulation. The behavioral trait was quite common in the cited Australian and South American species. A riding pair of *Xenophyes cascus* was observed once, but many specimens of this species that were kept in the laboratory never demonstrated this behavior.

Dorsoventral shaking of the abdomen was observed (and filmed, with kind assistance of Jürgen Deckert) in males of *Peloridium hammoniorum* and *P. pomponorum*. In the beginning, the abdomen builds a straight line with the rest of the body (the normal posture in Peloridiidae). The animal stabilizes itself with the legs, then lifts swiftly and slightly the whole of the abdomen and immediately lowers it as swiftly as before and relatively deep, but without touching the substrate. The whole movement takes slightly less than a second to complete: it is repeated, sometimes many times; the angle built by the abdomen between the highest and the lowest position is ca. 15-20°. After the first recordings of vibrational signals in these species were made, it became obvious that the signals are generated during this movement of the abdomen. A similar dorsoventral movement of the abdomen was once registered in a female of *Xenophyes cascus*, although the amplitude was less and the frequency higher; however, no vibrational signals could be recorded from females of this species (s. section 3.6. on intraspecific communication) and thus nothing can be said on the connection of this behavioural trait in this species and vibrational signals.

Jumping capacity of 8 specimens of *Xenophyes cascus* and one *Oiophysa cumberi* (both from New Zealand) was tested in a setting analogous to that used by Burrows et al. (2007) in their recording of jumps in the Australian peloridiid *Hackeriella veitchi*. The one *O. cumberi* was very reluctant to move at all and was tested for less than an hour. The *Xenophyes* specimens were tested ca. 5 hours total time. No jumps were observed in any of the species.

3.2 Host plants of Peloridiidae and their taxonomic affinities

In Australia, Peloridiidae were obtained from at least 17[1] different moss species (belonging to 3 different classes, 7 orders and 14 families – the traditional categories are mentioned here only to better demonstrate the extent of taxonomic diversity of the host plants). Among the liverworts, they were found on at least 9[2] species (2 subclasses, 3 orders, 6 families). In diagram 1., a detailed account on the species tested in Australia is given. Species that delivered peloridiids are written in green, those that not – in red, those that varied – in green and red. The number in brackets is the number of times the particular bryophyte species was analyzed:

Division Bryophyta (mosses)
Class Bryopsida
subclass Bryidae
o. Bartramiales
f. Bartramiaceae
Bartramia compacta (1[3])
Breutelia pendula (2)
o. Bryales
f. Bryaceae
Rosulabryum subtomentosum (1)
Rosulabryum billarderi (2)

[1] 19 species, if the *Dicranoloma* sp. that could not be identified exactly is whether *D. dicarpum* nor *D. menziesii*, and the *Sphagnum* sp. is not *S. cristatum*
[2] 10 species, if the *Lepidozia* sp. that could not be indetified exactly is not *L. multifida* or *L. ulothrix*.
[3] Single specimen

Rosulabryum torquescens (1)

o. Hookeriales

f. Daltoniaceae

Achrophyllum dentatum (1)

f. Hypopterygiaceae

Cyathophorum bulbosum (2)

Lopidium concinnum (1/1)

o. Hypnales

f. Brachytheciaceae

Kindbergia praelonga (1)

f. Catagoniaceae

Catagonium nitens (1)

f. Echinodiaceae

Echinodium hispidum (1)

f. Hypnaceae

Calliergonella cuspidata (1)

Hypnum chrysogaster (1)

f. Lembophyllaceae

Camptochaete arbuscula (1/1)

Camptochaete deflexa (1)

Camptochaete sp. (2)

Weymouthia cochlearifolia (1)

Weymouthia mollis (1)

f. Meteoriaceae

Papillaria[4] *crocea* (2)

Papillaria flavolimbata (1[5]/2)

Papillaria leuconeura (3)

Papillaria sp. (1)

f. Neckeraceae

Thamnobryum pumilum (1)

f. Pylaisiadelphaceae

Isopterygium albescens (1)

Wijkia extenuata (6/9)

f. Thuidiaceae

Thuidiopsis sparsa (1)

f. Trachylomataceae

Trachyloma planifolium (1)

o. Hypnodendrales

f. Hypnodendraceae

Hypnodendron vitense (1)

Hypnodendron spininervium (1)

Hypnodendron sp. (1)

o. Ptychomniales

f. Ptychomniaceae

Ptychomnion aciculare (3/3)

o. Rhizogoniales

f. Aulacomniaceae

Aulacomnium palustre (1)

f. Rhizogoniaceae

Pyrrhobryum parramattense (1[6]/2)

Rhizogonium distichum (1[7])

subclass Dicraniidae

o. Dicranales

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[4] The genus name *Papillaria* is not found in classification by Goffinet & Buck, since the genera *Meteorium* and *Papillaria* have experienced large taxonomic shifts lately, but the view of Huttunen et al. (2008) is followed here.

[5] Single specimen

[6] Single specimen

[7] Single specimen

- f. Dicranaceae
  - *Dicranoloma dicarpum* (3/4)
  - *Dicranoloma menziesii* (3/7)
  - *Dicranoloma robustum* (3)
  - *Dicranoloma sp.* (1/3)
- f. Fissidentaceae
  - *Fissidens oblongifolius* (1)
- f. Leucobryaceae
  - *Leucobryum candidum* (3/1)

Class Polytrichopsida

- o. Polytrichales
  - f. Polytrichaceae
    - *Atrichum androgynum* (1/1)
    - *Dawsonia superba* (2)

Class Sphagnopsida

- o. Sphagnales
  - f. Sphagnaceae
    - *Sphagnum cristatum* (2)
    - *Sphagnum sp.* (2/1)

Division Marchantiophyta (liverworts)

Class Jungermanniopsida

- subclass. Jungermaniidae
  - o. Jungermanniales
    - f. Acrobolbaceae
      - *Tylimanthus tenellus* (1)
    - f. Adelanthaceae
      - *Adelanthus bisetulus* (1)
    - f. Anastrophyllaceae
      - *Plicanthus hirtellus* (1/1)
    - f. Balantiopsaceae
      - *Balantiopsis diplophyllum* (1[8]/1)
    - f. Geocalycaceae
      - *Chiloscyphus limosus* (1)
    - f. Lepidoziaceae
      - *Bazzania adnexa* (3/5)
      - *Bazzania cf. crassitexta* (1)
      - *Bazzania fasciculata* (1)
      - *Lepidozia multifida* (1/2)
      - *Lepidozia septemfida* (1)
      - *Lepidozia ulothrix* (1)
      - *Lepidozia sp.* (1/4)
    - f. Plagiochilaceae
      - *Plagiochila baileyana* (1)
      - *Plagiochila fasciculata* (1)
      - *Plagiochila strombifolia* (2)
    - f. Schistochilaceae
      - *Schistochila lehmanniana* (2)
    - f. Trichocoleaceae
      - *Trichocolea mollissima* (2)
- subclass Metzgeriidae
  - o. Metzgeriales
    - f. Hymenophytaceae
      - *Hymenophyton flabellatum* (1[9])
    - f. Palaviciniaceae
      - *Podomitrium phillanthus* (1)
      - *Symphyogyna podophylla* (1)

Diagram 1. All bryophyte species from Australia that were tested in Berlese funnels as possible host species for Peloridiidae. The numbers in brackets behind the species name gives the number of samples tested; the samples that delivered Peloridiidae are in green, those that delivered none – in red. The species names of the respective bryophytes are also given in green or red or both colours, according to the same principle.

[8] Single specimen

[9] Single specimen

In Chilean localities, moss bugs were found on 10 moss species (from 6 different families, 6 orders and 3 classes) and 3 species of liverworts (from 2 families and 1 order of bryophytes).

Division Bryophyta (mosses)
Class Bryopsida
- subclass Bryidae
  - o. Bartramiales
    - f. Bartramiaceae
      - *Breutelia dumosa* (1)
      - *Breutelia subplicata* (1)
  - o. Hookeriales
    - f. Hypopterygiaceae
      - *Arbusculohypopterygium arbuscula* (1/2)
  - o. Hypnales
    - f. Hypnaceae
      - *Hypnum chrysogaster* (1[10])
    - f. Lembophyllaceae
      - *Weymouthia mollis* (1)
    - f. Sematophyllaceae
      - *Rhaphidorrhynchium callidum* (1)
    - f. Thuidiaceae
      - *Thuidiopsis furfurosa* (2)
  - o. Hypnodendrales
    - f. Hypnodendraceae
      - *Hypnodendron microstictum* (1)
  - o. Ptychomniales
    - f. Ptychomniaceae
      - *Ptychomniella ptychocarpa* (1)
      - *Ptychomnion cygnisetum* (4)
      - *Ptychomnion densifolium* (1)
- subclass Dicraniidae
  - o. Dicranales
    - f. Dicranaceae
      - *Dicranoloma billarderii* (1/5)
      - *Dicranoloma robustum* (1)
  - o. Grimmiales
    - f. Grimmiaceae
      - *Racomitrium geronticum* (1)

Class Polytrichopsida
- o. Polytrichales
  - f. Polytrichaceae
    - *Dendroligotrichum dendroides* (1)
    - *Polytrichadelphus magellanus* (3)

Class Sphagnopsida
- o. Sphagnales
  - f. Sphagnaceae
    - *Sphagnum capillifolium* (1)
    - *Sphagnum falcatulum* (5)
    - *Sphagnum fimbriatum* (2)
    - *Sphagnum magellanicum* (3)

Division Marchantiophyta (liverworts)
Class Jungermanniopsida
- subclass. Jungermaniidae
  - o. Jungermanniales
    - f. Geocalycaceae
      - *Chiloscyphus horizontalis* (1/1)
    - f. Lepidoziaceae
      - *Bazzania peruviana* (1)

[10] Single specimen

Pseudocephalozia quadriloba (2)

f. Plagiochilaceae

Plagiochila hookeriana (1/1)

Plagiochila lophocoleoides (1)

Plagiochila rubescens (1)

Plagiochila stictaecola (2)

f. Porellaceae

Porella subsquarrosa (1)

subclass Metzgeriidae

o. Metzgeriales

f. Aneuraceae

Riccardia prehensilis (1)

f. Metzgeriaceae

Apometzgeria frontipilis (1)

Diagram 2. All bryophyte species from Chile that were tested in Berlese funnels as possible host species for Peloridiidae. Colour code and numbers as in diagram 1.

Detailed information on the peloridiid species delivered by different bryophytes is found in Supplement 1. A remarkable pattern was observed: the genus *Peloridium* occured either on *Sphagnum* species or on *Polytrichadelphus magellanus* and not on other host plants (only a single specimen was found once on *Hypnum chrysogaster*) – whereas other Chilean species (*Idophysa chonos*, *Pantinia darwini* and *Peloridora holdgatei*) were found on different bryophytes, but never on *Sphagnum* or *Polytrichadelphus*.

In New Zealand, Peloridiidae were found on 22 species of mosses (from 13 different families, 8 orders and 3 classes) and at least 9[11] species of liverworts (from 7 families, 2 orders and 2 subclasses) – the full list is given below (diagram 3.). The host plant spectrum of New Zealand representatives is thus a little larger than that of Australian or Chilean Peloridiidae.

Division Bryophyta (mosses)

Class Bryopsida

Subclass Bryidae

o. Hookeriales

f. Daltoniaceae

Calyptrochaeta cristata (1[12])

f. Hypopterygiaceae

Canalohypopterygium tamariscinum (2)

Catharomnion ciliatum (1[13])

Dendrohypopterygium filiculiforme (4/1)

Hypopterygium rotulatum[14] (1)

Lopidium concinnum (2)

o. Hypnales

f. Climaciaceae

Climacium dendroides (1)

f. Echinodiaceae

Echinodium hispidum (3)

f. Hypnaceae

Hypnum chrysogaster (1)

f. Lembophyllaceae

Camptochaete arbuscula (1/1)

Camptochaete ramulosa (1[15])

[11] 10 species, if the *Schistochila* sp. from the list that could not be identified exactly is not *S. appendiculata*.

[12] Single specimen

[13] Single specimen

[14] The species is considered problematic in the monography by Kruijer (2002)

Weymouthia cochlearifolia (5)

f. Meteoriaceae

Papillaria[16] *leuconeura* (1)

f. Pylaisiadelphaceae

Wijkia extenuata (2/4)

o. Hypnodendrales

f. Hypnodendraceae

Hypnodendron comatum (1[17]/3)

Hypnodendron marginatum (1)

Hypnodendron menziesii (1)

f. Racopilaceae

Racopilum convolutaceum (2)

o. Ptychomniales

f. Ptychomniaceae

Ptychomnion aciculare (4/3)

o. Rhizogoniaceae

f. Rhizogoniaceae

Cryptopodium bartramioides (1[18]/1)

Pyrrhobryum mnioides (1)

subclass Dicraniidae

o. Dicranales

f. Dicranaceae

Dicranoloma billarderi (2)

Dicranoloma dicarpum (2)

Dicranoloma menziesii (1)

Dicranoloma plurisetum (1/1)

Dicranoloma robustum (1/1)

f. Leucobryaceae

Leucobryum candidum (3/4)

o. Grimmiales

f. Grimmiaceae

Racomitrium lanuginosum (1)

Class Polytrichopsida

o. Polytrichales

f. Polytrichaceae

Polytrichum juniperum (1[19])

Dendroligotrichum dendroides (1)

Class Sphagnopsida

o. Sphagnales

f. Sphagnaceae

Sphagnum cristatum (1)

Division Marchantiophyta (liverworts)

Class Jungermanniopsida

subclass Jungermaniidae

o. Jungermanniales

f. Acrobolbaceae

Tylimanthus saccatus (1)

f. Jungermanniaceae

Chandonanthus squarrosus (1)

f. Lepidoziaceae

Bazzania adnexa (3/1)

Bazzania novae-zelandiae (1)

f. Mastigophoraceae

Dendromastigophora flagellifera (1)

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[15] Single specimen

[16] Concerning the genus *Papillaria* s. the footnote in the Australian list of host plants.

[17] Single specimen

[18] Single specimen

[19] Single specimen

f. Plagiochilaceae
Plagiochila banksiana (1)
Plagiochila circinalis (1)
Plagiochila fasciculata (1)
Plagiochila gigantea (1)
Plagiochila ramosissima (2)
Plagiochila stephensoniana (2/1)
f. Porellaceae
Porella elegantula (1)
f. Schistochilaceae
Schistochila appendiculata (2)
Schistochila glaucescens (1)
Schistochila sp. (1)
subclass Metzgeriidae
o. Metzgeriales
f. Hymenophytaceae
Hymenophyton flabellatum (1)
Hymenophyton leptopodum (1)

Diagram 3. All bryophyte species from New Zealand that were tested in Berlese funnels as possible host species for Peloridiidae. Colour code and numbers as in diagrams 1. and 2.

In diagram 4., the information on host plants of Peloridiidae from diagrams 1.-3. is integrated; only the bryophyte species that delivered moss bugs are presented. The bryophytes that hosted the insects in Australia are written in green, in Chile – in blue and in New Zealand – in red:

Class Bryopsida
subclass Bryidae
o. Bartramiales
f. Bartramiaceae
Bartramia compacta (1)
Breutelia subplicata (1)
o. Bryales
f. Bryaceae
Rosulabryum subtomentosum (1)
o. Hookeriales
f. Daltoniaceae
Calyptrochaeta cristata (1)
f. Hypopterygiaceae
Arbusculohypopterygium arbuscula (1)
Catharomnion ciliatum (1)
Dendrohypopterygium filiculiforme (4)
Hypopterygium rotulatum (1)
Lopidium concinnum (1/2)
o. Hypnales
f. Brachytheciaceae
Kindbergia praelonga (1)
f. Echinodiaceae
Echinodium hispidum (3)
f. Hypnaceae
Hypnum chrysogaster (1)
f. Lembophyllaceae
Camptochaete arbuscula (1/1)
Camptochaete deflexa (1)
Camptochaete ramulosa (1)
f. Meteoriaceae
Papillaria flavolimbata (1)
f. Pylaisiadelphaceae
Wijkia extenuata (6/2)

- o. Hypnodendrales
  - f. Hypnodendraceae
    - *Hypnodendron comatum* (1)
    - *Hypnodendron menziesii* (1)
    - *Hypnodendron vitense* (1)
  - f. Racopilaceae
    - *Racopilum convolutaceum* (2)
- o. Ptychomniales
  - f. Ptychomniaceae
    - *Ptychomnion aciculare* (3/4)
- o. Rhizogoniales
  - f. Rhizogoniaceae
    - *Cryptopodium bartramioides* (1)
    - *Pyrrhobryum parramattense* (1)
    - *Rhizogonium distichum* (1)

subclass Dicraniidae

- o. Dicranales
  - f. Dicranaceae
    - *Dicranoloma billarderii* (1/2)
    - *Dicranoloma dicarpum* (3/2)
    - *Dicranoloma menziesii* (3/1)
    - *Dicranoloma plurisetum* (1)
    - *Dicranoloma robustum* (1)
    - *Dicranoloma sp.* (1)
  - f. Leucobryaceae
    - *Leucobryum candidum* (3/3)

Class Polytrichopsida

- o. Polytrichales
  - f. Polytrichaceae
    - *Atrichum androgynum* (1)
    - *Dendroligotrichum dendroides* (1)
    - *Polytrichadelphus magellanus* (3)
    - *Polytrichum juniperum* (1)

Class Sphagnopsida

- o. Sphagnales
  - f. Sphagnaceae
    - *Sphagnum capillifolium* (1)
    - *Sphagnum cristatum* (2/1)
    - *Sphagnum falcatulum* (5)
    - *Sphagnum fimbriatum* (2)
    - *Sphagnum magellanicum* (3)
    - *Sphagnum sp.* (2)

Class Jungermanniopsida (liverworts)

subclass. Jungermaniidae

- o. Jungermanniales
  - f. Acrobolbaceae
    - *Tylimanthus saccatus* (1)
  - f. Anastrophyllaceae
    - *Plicanthus hirtellus* (1)
  - f. Balantiopsaceae
    - *Balantiopsis diplophyllum* (1)
  - f. Geocalycaceae
    - *Chiloscyphus horizontalis* (1)
    - *Chiloscyphus limosus* (1)
  - f. Jungermanniaceae
    - *Chandonanthus squarrosus* (1)
  - f. Lepidoziaceae
    - *Bazzania adnexa* (3/3)
    - *Bazzania cf. crassitexta* (1)
    - *Lepidozia multifida* (1)
    - *Lepidozia ulothrix* (1)

Lepidozia sp. (1)
f. Plagiochilaceae
Plagiochila circinalis (1)
Plagiochila gigantea (1)
Plagiochila hookeriana (1)
Plagiochila rubescens (1)
Plagiochila stephensoniana (2)
f. Porellaceae
Porella elegantula (1)
f. Schistochilaceae
Schistochila appendiculata (2)
Schistochila lehmanniana (2)
Schistochila sp. (1)
subclass Metzgeriidae
o. Metzgeriales
f. Hymenophytaceae
Hymenophyton flabellatum (1)
Hymenophyton leptopodum (1)

Diagram 4. All bryophyte species found to accomodate Peloridiidae in the present study. Species from Australia are given in green, from Chile – in blue, from New Zealand – in red.

Thus, Peloridiidae in this study were found on total of at least 40[20] moss species (from 18 different families, 10 orders and 3 classes) and 20[21] liverwort species (10 families, 2 orders and 2 subclasses). The total number of higher taxa in mosses is, according to Shaw & Goffinet (2000): 6 classes, 23 orders, 116 families. Thus, Peloridiidae were found on representatives of 50% of moss classes, ca. 40% of orders and ca. 15% of families. Liverworts are divided into 2 subclasses, 10 orders and 57 families (Shaw & Goffinet, 2000) – Peloridiidae occurred on both subclasses, 20% of orders and 18% of families. Thus, Peloridiidae as a family does not demonstrate taxonomic preferences for particular higher groups of bryophytes.

Taxonomic differences in host plant preferences between Peloridiidae from different world parts do not seem to exist. It is obvious from the diagram 4. that whenever more than one species from a bryophyte family was analyzed, the family was found to host the insects in at least two different regions, and such families as Dicranaceae, Hypopterygiaceae, Polytrichaceae and Sphagnaceae even in all three.

Some of the bryophytes that were found to accommodate specimens of Peloridiidae are shown in the fig. 8. As for *Dicranoloma dicarpum* (fig. 8 A), *Wijkia extenuata* (fig. 8 B), *Ptychomnion aciculare* (fig. 8 E), *Sphagnum magellanicum* (fig. 8 G) and *Polytrichadelphus magellanus* (fig. 8 H), peloridiids were also observed feeding on them under laboratory conditions.

[20] 42 species, if *Dicranoloma* sp. from the list does not belong *to D. billarderii, D. dicarpum, D. menziesii, D. plurisetum* or *D. robustum*, and *Sphagnum* sp. – to *S. capillifolium*, *S. cristatum*, *S. falcatulum, S. fimbriatum* or *S. magellanicum*

[21] 22 species, if *Lepidozia* sp. from the list does not belong to *L. multifida* or *L. ulothrix*, and *Schistochila* sp. – to *S. appencidulata* or *S. lehmanniana*

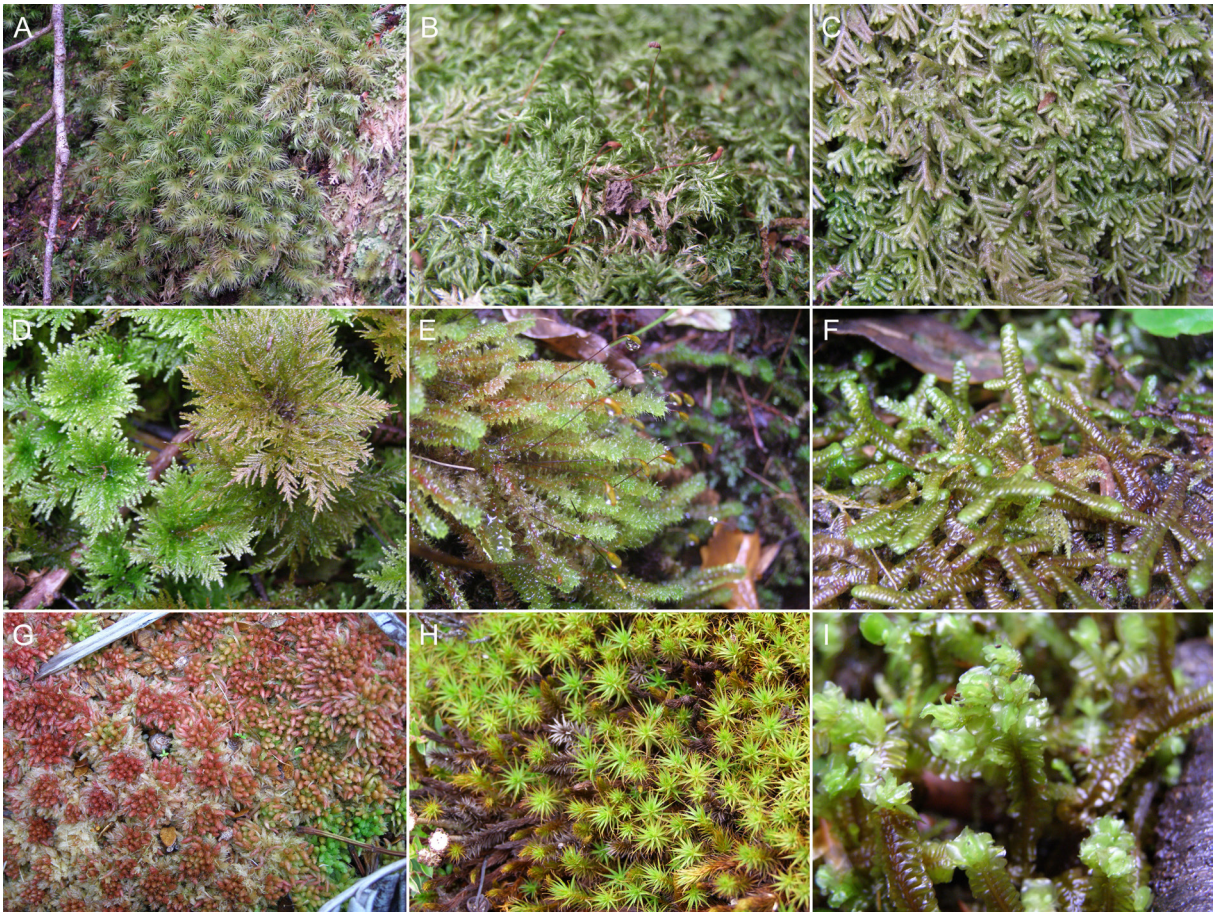

Figure 8. Host bryophytes of Peloridiidae. A – *Dicranoloma dicarpum*, B – *Wijkia extenuata*, C – *Lepidozia multifida*, D - *Dendrohypopterygium filiculiforme*, E – *Ptychomnion aciculare*, F – *Porella elegantula*, G – *Sphagnum magellanicum*, H – *Polytrichadelphus magellanus*, I – *Chiloscyphus horizontalis*. A-C: Australia, D-F: New Zealand, G-I: Chile. C, F, I – liverworts, the rest – mosses.

Inspite of the weekly pronounced host plant preferences among Peloridiidae as a whole, particular species or genera of the insects can show a certain degree of specificity in the choice of host plants (fig. 9.)

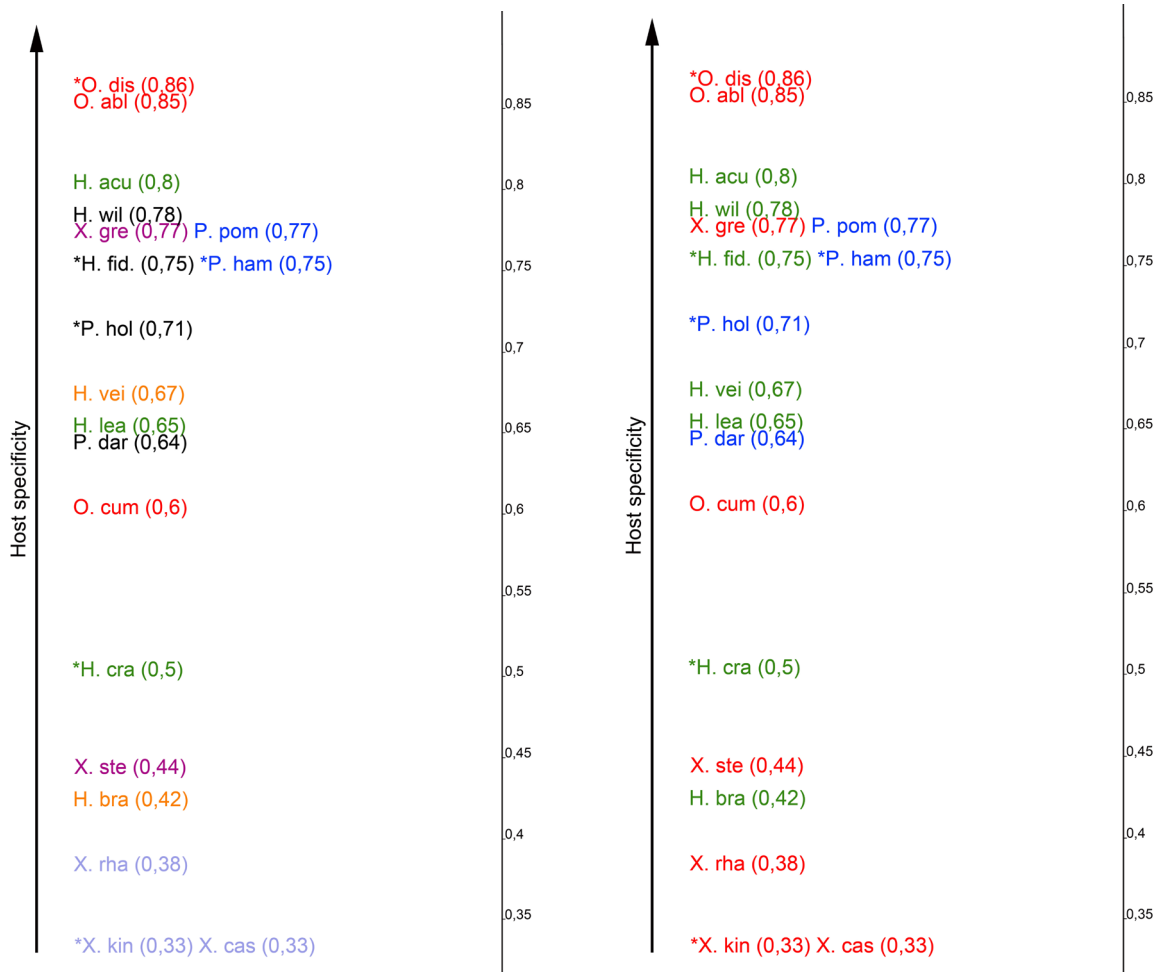

Figure 9. Host specificity in Peloridiidae, based on the specificity index S (in brackets). An asterisk before the species name indicates that N (total number of bryophyte species) is less then 10. Left side: the Peloridiidae species are highlighted according to taxonomy (monotypic genera are in black, species belonging to the same genus are given in the same colour). Right side: Peloridiidae species highlighted according to biogeographical regions (Australian species in green, Chilean in blue, New Zealand in red).

Whereas species of the genus *Xenophyes* live on most bryophyte species that occur in a given area and have low specificity, representatives of *Oiophysa* are very selective. *O. ablusa* was only found on two representatives of the moss order Dicranales (*D. robustum* and *L. candidum*) and *O. distincta* only on the species *Dendrohypopterygium filiculiforme* (Hookeriales: Hypopterygiaceae), in two different locailities. Still, even when only these two *Oiophysa* species are compared, their host plant affinities vary quite strongly. If the third analyzed species of this genus, *O. cumberi*, is taken into account, the taxonomic variability grows even more: the species occurs on *Camptochaete arbuscula*, *Echinodium hispidum* (both o. Hypnales, but from different families), *Lopidium concinnum* (o. Hookeriales, f. Hypopterygiaceae) and possibly on *Ptychomnion aciculare*, too (o. Ptychomniales, f. Ptychomniaceae). Thus, a pattern that is common among herbivore insects, when closely related insect species feed on closely related host species (e. g. Rausher, 2001), is not followed by Peloridiidae.

The genus *Xenophysella* is somewhat intermediate between the unspecific *Xenophyes* and the highly specific *Oiophysa*. Whereas *X. stewartensis* was not specific and occured on liverworts and different

mosses alike, *X. greensladeae* was only found on three liverwort species *Plagiochila gigantea*, *Schistochila appendiculata* and *Tylimanthus saccatus.* Each of those belongs to a different family within the order Jungermanniales, but a strong affinity towards liverworts is a specific trait.

South American representatives group fairly tightly together in the fig. 9. (specificities of 0,63 to 0,71). *Peloridium hammoniorum* was found almost exclusively on *Polytrichadelphus magellanus* (only once on *Sphagnum falcatulum*), whereas its congeneric *P. pomponorum* mostly occurred on different *Sphagnum* species, although was also once recorded from a *Hypnum* and *P. magellanus* (s. Supplement 1.). Remarkably, all other Chilean species of Peloridiidae that were collected did not occur on *Sphagnum* or *P. magellanus*, but on several other bryophyte species, thus avoiding the host plants that were preferred by *Peloridium* species. When bryophytes were analyzed separately, *P. holdgatei* was only found on one or two liverworts of the genus *Plagiochila* – although it is most likely not restricted to it, since when mixed samples of bryophytes were collected, it was obtained from several of them with a very different taxa assemblage.

Australian Peloridiidae all seem to be fairly selective in their choice of host plants. The quite low selectivity index of *H. crassus* (fig. 9.) might be an artefact due to the fact that this species could be collected at only one locality, where only two bryophyte species were sampled (thus N = 2). Higher specificities of some sympatrically and syntopically occurring species as *Hemiodoecus acutus* and *Hemiowoodwardia wilsoni* might in reality be lower, since some samples where only young larvae were obtained (that could not be assigned to a certain species) had to be omitted from the analysis, thus making the specificity index higher[22]; same might be true for Tasmanian species *H. fidelis* and *H. leai*. But still, as South American representatives, the Australian ones demonstrate higher degrees of specificity than the specimens from New Zealand (except the genus *Oiophysa* and one *Xenophysella* species). This is further illustrated by the fact that in habitats where *Sphagnum* was available, the Australian *H. leai* and the South American *P. pomponorum* were found almost exclusively on it – but not the New Zealand *X. kinlochensis*, that also occurred in several other bryophytes even when *Sphagnum* was readily available.

[22] The specificity index calculated for both the adult specimens *H. acutus* and *H. wilsoni* together with the unidentifiable larvae is 0,63 – in contrast to 0,83 for adult *H. wilsoni* and 0,81 for adult *H. acutus*; s. Supplement 2.

3.3 Characters pertaining to fine morphology

3.3.1 Peloridiidae

3.3.1.1 Characters of the head

Antennae

The antenna in Peloridiidae consists of 3 segments: scape, pedicel and a single-segmented flagellum (plate[23] fig. 1). Scape and pedicel are conical and bear some microtrichia, integumental glands and trichoid sensilla. The base of the flagellum is petiolate and in most cases covered with scales that can be more or less pronounced, depending on the species. The rest of the segment is fusiform and much thicker. The fine details of the flagellum form may vary between species, especially in caudal view: the flagellum may be more or less thick in relation to its length, its dorsal side (in caudal view) may be more or less straight, convex or even slightly concave (whereas the ventral side is uniformly convex in all species); there may be a constriction defining the tip (all these characters are species-specific; s. Supplement 3. figs. 5-6). The tip of the flagellum is occupied by a large placoid sensillum perforated by numerous very fine, nanometer-scale pores (plate figs. 2-3). It is normally prolonged as a narrow stripe along the dorsal margin of the flagellum and is bordered by a strip of especially smooth cuticle (the border is not always clearly to see). In the genus *Peloridium*, the placoid sensillum is engirdled by a cuticular furrow (plate fig. 4). The region of the antenna bearing the sensillum in the living animal sticks out dorsally between the paranotum and the head and is open to the influence of the environment (plate fig. 5), thus implying a sensory role for the organ.

There are several coeloconic sensilla (5-9 in number; pores ca. 1 µm in diameter) close to the placoid sensillum (plate figs. 2-3), not located in any particular order (the pattern of the pores normally differs even between the left and the right antenna of the same specimen). The only exception is again the genus *Peloridium* in which the pores are slightly bigger than in other peloridiid species and are ordered in a more or less straight line along the posteriordorsal margin of the flagellum (plate fig. 4). This row is separated from the sieve organ by the aforementioned furrow. Although there is normally no strict order of coeloconic sensilla in species others than *Peloridium*, some species-specific differences in the extension in which the sensilla may stretch basad along the flagellum and in their number do exist. The coeloconic sensilla in the living animal are facing caudad. The fine structure of coeloconic sensillum in *Oiophysa ablusa* (plate fig. 5, inlet) and some other Peloridiidae species shows a sensillum with a tip where some concentric structures are joined.

On the ventral surface of the flagellum, there are several (1 to 5, depending on the species) smooth socketed trichoid sensilla (s. plate fig. 4B for a close-up), one of which is always located close to the tip and the border of the placoid sensillum; also, integumental glands are often present. Basal third of the flagellum is imbricated (e.g. plate fig. 1); further distad the borders between scales gradually become deep folds of the cuticula. The apical third is normally smooth, but some of the folds

[23] Figures produced with scanning electron microscopy are put together as plates in the section 8 and are referred to as “plate figures” – in contrast to text figures that are given on the spot where they are mentioned and are refered to simply as “figures”. Plate figures and text figures are numbered independently.

continue onto it. The scales normally are more widespread on posterior and dorsal surfaces than ventrally. The degree of extension of the scales on the flagellum is species-specific, on the stipe as well as on the fusiform part.

Judging from the several species where it was analyzed, the development of antennal segments might be variable within the family. In *H. brachycephala,* the first 4 larval instars have single-segmented antennae, whereas in the fifth there appears a suture between the scape and the rest, making the antenna two-segmented (plate fig. 6). In the two analyzed 5th instar nymphs of *Xenophyes cascus,* the border between the scape and pedicel, although clearly indicated as a constriction, still is not a complete intersegmental border (plate fig. 8a), the antenna being single-segmented. In its congeneric *X. rhachilophus* (5th instar) the condition of the antenna is perplexed: viewed from one angle, there is a complete border between the scape and the rest of the antenna (plate fig. 7b), whereas at another angle the intersegmental border is still not complete (plate fig. 7a). This might be a sputter-coating artefact; although this is unlikely since no other case was observed in our studies where an intersegmental border would be obscured by sputter coating. In *P. hammoniorum*, even the border between the antenna and the body is not clearly pronounced in the first two larval instars (plate fig. 8b), the antenna being de facto non-segmental. From the 2nd instar on the constrictions implying future intersegmental borders appear, but only in the last 5th instar the scape is completely separated from the rest of the antenna, rendering it two-segmented.

All the sensory structures described above that are found in adults (placoid sensillum, coeloconic sensilla etc.) are also present in larvae from the first instar on, differing from the adults only in size or number, but overall resembling very much the adult condition. The only difference is the placoid sensillum in young *Peloridium* larvae that appears so perfectly separated from the rest of the antenna that it almost looks like a separate segment (plate fig. 8b), but later in the development it acquires an appearance similar to the adults, although retains a furrow separating it from the rest of the flagellum that is characteristic to the genus.

Genal area under antenna

The genal area of the head immediately adjacent to the antenna is variable within the Peloridiidae and provides characters for phylogenetic analysis. The area may be flat or concave; it may carry sculptural elements and/or punctation or be more or less free of them, and the elements can vary in form or structure (Supplement 3., figs. 7-10.). In *Xenophyes cascus*, there is polymorphism in number and form of the sculptural elements (plate fig. 9), whereas in other species this character seems to be stable. The hind head margin, that builds the posterior border of the area, can be reflexed in some specimens of *Peloridium pomponorum*, so that it almost envelopes the antenna (plate fig. 10a). In *Peloridium* species the genal area is covered with wax-like secretion (Hartung et al., 2016) which might render this area water-repellent (plate fig. 11).

The head region that in adult peloridiids covers the antenna dorsally develops only after the imaginal moult. In larval instars the region itself is much less pronounced and the antennae are covered dorsally by the pronotal paranota that in some species seem to be grown together with the head

(plate fig. 12). Nevertheless, the microsculptural elements and integumental glands are already present in larvae (plate fig. 12).

Labium tip

The labium of Peloridiidae consists of four segments (Spangenberg et al., 2013), more or less densely covered on the sutural side with sculptural elements, trichoid sensilla and integumental glands. The tip of the labium bears the most phylogenetically relevant structures. Depending on the species it can be almost flat, skewed to the antisutural side or lipped (plate fig. 13). The tip of the labium in the caudal view bears the 4 outer and two inner pairs of trichoid sensilla (plate fig. 14A) reported by the previous workers (Brożek, 2007; Spangenberg et al., 2013). Outer sensilla appear smooth in SEM (plate fig. 14B), whereas the smaller inner sensilla, at least in *Pantinia darwini*, seem to have several large pores (plate fig. 14C). The outer sensilla are arranged in a wide circle on the periphery of the labium tip; this configuration is stable within the family. The order of inner sensilla shows a remarkable variation. In some representatives, both pairs of the inner trichoid sensilla are arranged symmetrically on the right and left side of the opening of the labium (plate fig. 15A), whereas in others they are concentrated on its antisutural side (plate fig. 15B). This configuration of sensilla correlates with a peculiar twist of the mandibular stylets that is visible in some species. All of the Australian and South American species in our study (except *Peloridium*) have the mandibles in normal lateral position and the inner trichoid sensilla are concentrated antisuturally (plate fig. 16A). In all analyzed New Zealand species and in the South American genus *Peloridium*, the inner sensilla are located laterally and the stylets are twisted distally at almost 90° (plate fig. 16B). Under both configurations, the inner circle of the sensilla seems to be always located where it can be in contact with the broad side of the stylet bundle.

The number of the trichoid sensilla may sometimes vary, especially in the outer circle – five (one specimen of *H. leai*) or three (one specimen of *H. wilsoni*) may occur here. The inner sensilla were found to vary in number only in the genus *Peloridium*: one or three may occur, along with the normal number of two. There was no correlation with sex, population or host plant – the only regularity is that the abnormal numbers of inner sensilla in our study always occurred on the right side (in two of 7 *P. pomponorum* specimens that were analyzed and in one of 5 *P. hammoniorum*).

The sensory configuration of the labium tip includes not only trichoid sensilla. There is a coeloconic sensillum on each side of the outer circle of the trichoid sensilla that was found in every species studied. Some specimens sometimes lack the coeloconic sensillum on one side (e.g., one *X. kinlochensis* in our analysis), although this seems to be only an individual variation. The fine structure of the coleoconic sensillum is variable – in all Australian, most South American and some New Zealand species it is multiporous (plate fig. 17A), whereas in *Peloridium* and New Zealand *Oiophysa ablusa* and *Xenophyes* it bears a single pore on its tip (plate fig. 17B). In some cases a multipororus sensilla has a relief that suggests it might also bear a large terminal pore (plate fig. 17C), although such cases must be studied more closely. Also, in genus *Peloridium* the sensillum is strictly speaking not a coeloconic one – it is not set in a cuticular depression as in all other species, but in a structure that can be considered an elevated socket (plate fig. 17D).

It is worth mentioning that coeloconic sensilla of similar appearance can also be found elsewhere on the body, as for instance on the pygophore of a *X. stewartensis*.

The form, number and other characteristics of the sensilla on labium tip and the twist of the stylets in larvae were the same as in adults of the 4 species where both adults and larvae were studied.

3.3.1.2 Characters of the thorax

Surface sculpture of the tegmina

Tegmina in Peloridiidae have peculiar structure with unique venational features (plate fig. 18; nomenclature of veins and cells after Burckhardt, 2009). The dorsal surface is mostly smooth (only in some species microtrichial sculpture is present on e.g. costal cells, s. plate fig. 22). Veins carry short socketed trichoid sensilla, and integumental glands are common. In most species, the R vein and all veins lying medially of it are bordered by punctation, whereas in some the punctation is limited to only two veins and in the genus *Peloridium* completely absent. The ventral surface is more complicated in structure (plate fig. 18b, plate fig. 19). Costal vein and all costal cells (if present) between it and subcostal branches have the same structure as the dorsal surface in the given species: smooth, bearing integumental glands, with trichoid sensilla on veins; microtrichia are only present in species, in which they are present on the dorsal surface. The ScP and the entire tegmen lying further medially from it are set off from the costal region and differ strikingly in the surface sculpture (plate fig. 19). As already reported by Hartung et al. (2016), this part bears acanthae and microtrichia and is covered by wax-like secretion, analogous to the abdominal tergites. The ScP-medial region is located directly above the plastron structures of the abdominal tergites and most likely plays a part in holding the air bubble. In the genus *Peloridium*, the cuticular protuberances are absent, but the waxy secretion is there (plate fig. 19d). In all other studied species, the cuticular protuberances may cover almost the entire ventral surface of the tegmen (plate fig. 19a), parts of it (plate fig. 19b) or concentrate predominantly on the veins (plate fig. 19c). The sculptural elements themselves may be of different form or size: scales are the most common ones (plate fig. 20a), but pegs (plate fig. 20b) or elements of more complicated form (plate fig. 20c) occur as well. Sometimes the tegmina of a species bear only elements of one type (plate fig. 21a), sometimes of more than one (plate fig. 21b). In some species, there is a sculpture-free (“bare”) spot on the apical radial cell (s. plate fig. 18b) whose function is elusive. In general, the diversity and variation of the cuticular armature of the tegmina is so high that it would be possible to construct a key and recognize most species of Peloridiidae basing on it alone.

Individual development of the tegminal armature is another trait where the genus *Peloridium* differs from others. *Peloridium* larval stages bear ventrally some bump-like microtrichia that are covered with wax-like secretion, not only on tegminal buds, but also on the hind wing buds that are completely reduced in older instars (plate fig. 23a). This is quite unexpected, since in adult insects the cuticular protuberances on ventral side of the tegmina are almost completely reduced. In *X. cascus* and *H. brachycephala* the situation is the contrary: the larvae do not bear microtrichia on the ventral

side of tegminal buds, and the wax-like secretion, if present, is confined to the area around spiracles (plate fig. 23b) – thus, all the tegminal sculpture in these species develops after the imaginal moult. The elements that could be confused with microtrichia in *X. cascus* or *H. brachycephala* are integumental glands (*ig* in the plate fig. 23b) and will be treated below.

Distal hind leg

In most Peloridiidae, the tip of the tibia of the hind legs is armed with up to 4 spurs – robust acanthae (Gorb, 2001) with a solid base, easy to discern from socketed trichoid sensilla in SEM (plate fig. 24). The spurs were initially described in a study of jumping behavior of *H. veitchi* (Burrows et al., 2007, fig. 7D) and could play a role in that behavior, providing better grip on substrate. The number of the spurs, although variable between species, is highly stable within one – with exceptions of *Hemiowoodwardia wilsoni* and *Peloridium pomponorum* that in our analysis had numbers varying from 2 to 4 or 3 to 4, respectively, without obvious correlation to sex or population. In species with 4 tibial spurs, these can be arranged symmetrically, with two ventrally and one on each side (Supplement 3. Fig. 1. A-B i.a.), or asymmetrically, with one ventral, one inner lateral and two outer laterals (Supplement 3. Fig. 1. F-G i.a.)

The tarsus of Peloridiidae is two-segmented. The proximal segment (further on referred to as T1) has the form of a truncated cylinder (long ventral side and short dorsal side, s. plate fig. 24.) and carries 1-4 pairs of setae on the ventral side; its tip can be broadly rounded or somewhat tapered. The number of setae on T1 is mostly relatively stable within a species, but can vary significantly in some (e.g., in *Xenophyes cascus* it was 2±0,1 with n=14, whereas in *Pantinia darwini* 2,7±0,8, with n=8). The distal segment (T2) is 2-3 times longer than the proximal one, cylindrical and carries several longitudinal rows of setae; the two ventral rows have 3-7 setae in them (other rows might also be taxonomically relevant but were not considered here). Just as with setae on T1, those on T2 are mostly stable in number within a species, although in some it does vary significantly (e.g., *Pantinia darwini*, *Hemiowoodwardia w*ilsoni). For *P. darwini*, the high variation in number of setae was not a character of sexual dimorphism or individual variation. Setae on T1 or on T2 have shown no obvious variation between the left and right leg within a species, with the only exception of *Hackeriella brachycephala*, where in 3 specimens analyzed the right foot always had more setae on T2 – although the sampling here is too poor to state anything with certainty (s. Supplement 4). The ventral distal margin of T2 carries a mechanosensory (most likely) seta on each side (plate fig. 24c).

In the pretarsus (plate fig. 24b-c), there is an unguitractor with three longitudinal rows of cuticular scales; the median row starts and ends closer to the proximal end of the unguitractor than the lateral rows do; the number of scales in all three rows is in most cases the same; for the phylogenetic analysis, it was determined for lateral rows in each specimen where the unguitractor was visible and amounts to 2 - 6. The membranous part between the tip of unguitractor and base of claws or on the sides of the arolium base may be smooth or carry microtrichia. The arolium between the claws is sack-like, consisting of a single lobe. It carries two small symmetrical unsocketed setae (plate fig. 24c, arrows), presumably of sensory function, on the ventral side (China, 1962, depicts them in fig. 3d and e, although without explicitly mentioning in the text). The dorsal side of the arolium carries a

socketed trichoid sensillum (plate fig. 24b). The claws are of moderate size, pyramidal, curved, with 2-3 ridges on the ventral surface.

Larvae of all stages that were analyzed in our study had two-segmented tarsi (i. a. the first instars of *P. hammoniorum*, second instars of *H. brachycephala* or third instars of *X. cascus*), which corresponds well with results of Chen & Yang (1995) who studied larvae of several other peloridiid species. With but one exception, all the feet structures described above for the adults were already present in the larvae, their tarsi only differing in size and number of the setae they carry. The only structures limited to the adults were the tibial spurs on the hind legs. Larvae of *H. brachycephala* or of the genus *Peloridium* (these species have tibial spurs as adults) carry only socketed setae on the tip of tibiae (plate fig. 25). Although some of the setae seem to be more robust than others, it is not clear if the tibial spurs of the adults are homologous to them or develop de novo.

3.3.1.3 Characters of the abdomen

Water-repellent structures and surface of the dorsal abdomen

Structural plastron was recently reported for Peloridiidae (Hartung et al., 2016). It is formed by cuticular protuberances on dorsal abdomen and parts of dorsal and lateral meso- and metathorax that are covered with wax-like secretion (plate fig. 26). Although the plastron structures are built similarly in all species studied, they do differ in detail. The wax-like secretion may cover the whole of the dorsal abdomen or may be absent on some parts of it (plate fig. 26). Where the wax-free regions on terga exist, integumental glands normally occur on them and have the habitus similar to the glands elsewhere on the body (plate fig. 26). In some species, glands also occur on tergite parts covered by wax and here they can differ in structure from the glands elsewhere on the body or be similar to them (plate fig. 27). The microtrichia that cover the dorsal surface of the abdomen may differ in size or arrangement, e.g. be single or joined, be spread more or less uniformly or occur in groups (plate fig. 28). It must be mentioned that the arrangements of microtrichia are not absolute, i.e. on the same specimen some microtrichia might be single, some joined and some grouped – but there is a predominant pattern for every species that can be used for phylogenetic analysis.

The form of the first abdominal tergite is also variable. It shows significant interspecific variation: the sclerite may be short and broad (plate fig. 29b) or longer but narrower (plate fig. 29a)[24]. The length and width of the sclerite that is bordered posteriolaterally by two apodemes ("pla" in plate fig. 29) was taken as a proxy for the size of the 1. abdominal tergite. The form and arrangement of the posterolateral apodemes varies with the measures of the first tergite: in longer and narrower tergites there are two lateral folds that are joining the posterior apodeme in an obtuse angle (plate fig. 29a), whereas broader and shorter tergites have the lateral apodemes almost completely reduced with only the posterior fold remaining (plate fig. 29b).

[24] The length of the sclerite is measured along the body axis and the width across it – thus, the narrow tergite 1. in fig. 18b is called "short", etc.

Individual development of the plastron structures may vary significantly within the family. Thus, in *H. brachycephala* and *X. cascus* the plastron structures in larvae are restricted to the first two abdominal tergites (plate fig. 30a) and thus the most of the plastron must appear after the imaginal moult. In *Peloridium,* plastron structures become more and more pronounced as the larva grows, covering parts of ventral and dorsal thorax (plate fig. 30b), abdomen and even head, although here as well much of the adult plastron develops only after the final moult.

3.3.1.4 Characters of the general body surface

Integumental glands

All Peloridiidae species studied exhibited numerous cuticular structures that resembled integumental glands in other Hemiptera (e.g. Lawrence & Staddon, 1975). This resemblance and some other considerations (for detailed account on the possible identity of the structures s. Discussion, chapter 4.2.1.4.) suggested that the structures in question are integumental glands, too. They are treated here as such.

The glands are especially numerous on flat body regions, such as abdomen surface, head areolae, pronotum or dorsal surface of the tegmina. Fine details of structure are pretty stable within the species but can vary significantly between them, rendering the glands useful for phylogenetic analysis of the family. Two types of gland openings were observed: a simple pore in the cuticle (like "simple glands" of Lawrence & Staddon, 1975) and openings surrounded by papillae-, club- or finger-like peripheral elements ("floral glands" of Lawrence & Staddon, 1975) (plate fig. 31). Only the second type is discussed here, since simple pores do not show any variation. All peripheral elements of the gland may have the same appearance or may be divided into an inner and outer group. The elements of the inner group are generally smaller and immediately surround the gland opening, sometimes lying flat over it as if building a strongly sinuous outline of the opening (plate fig. 32a), in such cases it might be difficult to decide if inner elements have to be differentiated or if those are just strongly sinuous margins of the gland opening. Outer elements are larger and always finger-like; sometimes they have a clubbed tip. The number of inner and outer elements is quite stable within the species and mostly similar between closely related ones. The gland opening with the inner peripheral elements may be sunken into the cuticle (plate fig. 32b) or be on the same level with the outer elements. The glands are mostly developed uniformly throughout the body, although in some cases glands on head and pronotum may differ in number of the outer elements or in the degree of their elevation above/depression below the cuticula level (e.g. compare plate figs. 33 a and b). Also, whereas the most species do not have integumental glands on abdominal tergites, these do occur here in some species, on regions that are free from plastron (plate fig. 34) or even on those occupied by it. If present under the plastron, the structure of the glands here may be different from the glands elsewhere (plate fig. 35) or be similar. The glands under plastron, even if present, are set sparser than those elsewhere on the body.

Quite astonishingly, the form of the integumental glands in larvae is strikingly different from that in adults. Whereas the adult glands mostly have a sunk-in opening surrounded by peripheral elements, larval glands open on elevated cuticular knobs (on the tip or on the side), the opening also surrounded by peripheral elements. Those may be differentiated into inner and outer elements (plate fig. 36). The form of the larval glands is less variable than in adults, but still enough differences may exist even between closely related species. For instance, in larvae of *Xenophyes cascus* the glands carry 4-5 very short peripheral elements, whereas larval glands of *Xenophyes rhachilophus* mostly just have 2 much longer ones (plate fig. 37).

3.3.2 Outgroups

3.3.2.1 Characters of the head

Antennae

Sternorrhyncha. The antenna of *Psylla alni* consists of scape, pedicel (both thick and short) and a long thread-like 8-segmented flagellum (plate figs. 38-39); the 6th flagellomere is the longest, the terminal one is the shortest. The surface of scape and pedicel is imbricated; flagellomeres are subdivided by the surface sculpture into numerous pseudosegments. All segments of the antenna carry socketed grooved trichoid sensilla that have no visible pores (plate fig. 38B). Basiconic sensilla with finely porose surface were found only on the 7th flagellomere (plate fig. 39C). Flagellomeres 4, 6 and 7 carry laterally on the distal end large coeloconic sensilla that are referred to as rhinaria or sensoria in related taxa (e.g. Moran & Brown, 1973 in Triozidae); one of these sensilla had a protuberance visible inside the pit (plate fig. 39D). The terminal flagellomere carries two robust long protuberances (plate fig. 39) that in other psyllid or aleyrodid species are referred to as “apical setae” (e.g. Onagbola et al., 2008), “terminal hairs” (e.g. Mellor & Andersen, 1995) or “sensilla chetica” (Soroker et al., 2004). These apical sensilla have numerous fine pores on the surface and a large terminal pore (plate fig. 39B).

Cicadomorpha. The antenna of *Cercopis sanguinolenta* is three-segmented (plate fig. 40); scape and pedicel are thick, relatively short, imbricated and carry only few sensilla basiconica (scape) and socketed trichodea (pedicel). The tip of the pedicel is concave, with a small campaniform sensillum, and the bulbous imbricate flagellum base is somewhat sunken into it. It carries three large sensilla basiconica with finely porose surface that are set in shallow cuticular depressions (plate fig. 40B) and 25 large sensilla coeloconica that are facing caudad (plate fig. 40C-E). Among the coeloconic sensilla, two types can be recognized: larger double-walled sensilla where the central sensory structure on the bottom is readily visible and valved (plate fig. 40D) and smaller single-walled ones where the sensory structure is located much deeper and appears not sculptured (plate fig. 40E). The bulbous base of the flagellum continues into a long arista that is subdivided into pseudosegments by sculptural elements.

The scape of *Cicadella viridis* (plate fig. 41) is the broadest segment; it is roughly cylindrical in outline and normally sclerotized, except for the side facing caudad: it is membranous and probably enables

backfolding of the antenna. The pedicel is narrower and slightly longer, also cylindrical in outline and covered with scale-like acanthae. It carries several socketed trichoid sensilla and some integumental glands are recognizable. The base of the flagellum is petiolate, then fusiformly inflated and the distalmost part continues into a long arista (plate fig. 41A). In the flagellum, two segment borders can be recognized basally (plate fig. 41B), rendering flagellum three-segmented. On the base of the flagellum there are 3 socketed trichoid sensilla of different length (located dorsocaudally), at least the basalmost of which has a finely porose surface (plate fig. 41C). Each of the sensilla is located on the tip of a segment. Ventrally on the flagellum, several campaniform sensilla can be seen; like the sensilla trichodea, they are located close to the distal border or the respective segment or a pseudosegment.

Fulgoromorpha. The antenna of *Laodelphax striatella* consists of 3 segments: robust thick scape and pedicel and a single-segmented flagellum (plate fig. 42). The pedicel is the thickest segment of all and is almost as long as the flagellum. Scape and pedicel have imbricated surface and carry one or two campaniform sensilla and many trichoid sensilla with elevated sockets (plate fig. 43b, d). Pedicel also bears basiconic sensilla whose bases are sunken into depressions of cuticle and whose surface is rich in pores (plate fig. 43b-c), and plaque organs that are typical of Fulgoromoprha (Marshall & Lewis, 1971) (plate fig. 43a). The single-segmented thin flagellum has a bulbous base that in our specimen is sunken into the tip of the pedicel; the base bears a Bourgoin's organ and three basiconic sensilla (plate fig. 42c). The long arista of the flagellum seems to be bereft of sensilla; it is subdivided by surface sculpture into several pseudosegments.

The antenna of *Issus coleoptratus* is very similiar to that of *L. striatella*: a short scape that is almost bare of sensilla, a bulky pedicel with olfactory plaque organs (plate fig. 45), non-porous socketed sensilla trichodea and multiporous sensilla basiconica (plate fig. 45), and an arista-forming flagellum (plate fig. 44). The flagellum is petiolate at the very base and then bulbously inflated (plate fig. 44), similar to the condition in *L. striatella*. It carries Bourgoin's organ with the two typical coeloconic sensilla, and three basiconic sensilla (plate fig. 44b); the rest of the flagellum is protruded into a long thin arista with no clear segment or pseudosegment borders. There is a large campaniform sensillum on the pedicel close to the base of the flagellum (plate fig. 44b).

Heteroptera. Ceratocombus sp. has 4-segmented antenna (plate fig. 46a). The scape is relatively short and stout, subcylindrical, somewhat curved. The pedicel is ca. 3 times longer, in its thickest part almost as thick as the scape. The two flagellar segments are at most half of the pedicel in diameter, but very long; the basal segment is connected to the pedicel by an even thinner petiolus. Two types of sensilla can be seen: first, socketed trichoid sensilla with grooved surface and hooked tips that are present on every segment of the antennae (plate fig. 46b-c). The other type, a basiconic sensillum, is restricted to the flagellum but is much more numerous here than the trichoid sensilla (plate fig. 46b, d): basiconica are shorter, do not have a socket, but instead an elevated conical base with a constriction close to it and are somewhat flattened (and probably inflatable); the surface is finely grooved and porose (plate fig. 46d). No coeloconic or campaniform sensilla were seen.

In *Saldula saltatoria* the antennae are 4-segmented, with all segments cylindrical and relatively long, scape and both flagellar segments subequal and pedicel being the longest one (plate fig. 47a). There is a small pre-segment on the base of each flagellomere (plate fig. 47a). All antennomeres carry

trichoid sensilla, relatively sparse on scape and the base of pedicel, more numerous on its tip and on both flagellar segments. Trichoid sensilla are mostly longer than other types, grooved, socketed and erect (plate fig. 47b). Besides the trichoid type, three different types of basiconic sensilla were found, occurring only on flagellum. Representatives of the first are especially numerous, cling quite tight to the surface, do not have a socket, but a smooth surface (plate fig. 48c) and a curly tip. The second type embraces very few basiconic sensilla with no visible pores or grooves (plate fig. 48b). Representatives of the third type were found only on the distal end of the terminal flagellomere; their tip is regularly grooved (plate fig. 48a, sb III). The tip of the terminal flagellar segment is distinctly offset from the rest of the segment; a structure was found there that could be a coeloconic sensillum (plate fig. 48a), although it seems too damaged to allow any conclusions.

Corythucha ciliata has 4-segmented antennae (plate fig. 49). The scape is cylindrical and ca. thrice as long as it is thick; the pedicel is only twice as long as it is thick (and is of ca. the same thickness as the scape). Both segments carry quite sparse and short socketed trichoid sensilla. The first flagellomere is the longest antennomere; it is cylindrical in shape and only insignificantly thinner than the scape or pedicel. It carries ca. dozen very long erect socketed trichoid sensilla on its median side (marked with double asterisks in plate fig. 49a) and shorter socketed trichoid sensilla occurring everywhere else (simple asterisks in plate fig. 49a). There are also non-socketed basiconic sensilla with finely porose surface (sbp I, plate fig. 49b) on the segment. The terminal flagellomere is club-shaped and the density of sensilla is the highest here. There are long and short socketed trichoid sensilla (as on the first flagellomere) and several types of basiconic sensilla: the multiporous non-socketed type (sbp I) that is also found on the first flagellomere, porose non-socketed sensilla that are longer than sbpI (sbpII in plate fig. 49c); non-porose non-socketed sensilla (sb-np in plate fig. 49c) and sensilla with grooved tip (sbg in plate fig. 49c), found exclusively on this segment). Sensilla with the grooved tip are concentrated on the tip of the segment, where at least 7 of them were found.

Antennae of *Pyrrhocoris apterus* (Pentatomomorpha: Pyrrhocoridae) are 4-segmented, with all the segments being cylindrical; scape and pedicel are slightly longer than both flagellar segments (plate fig. 50). The scape is constricted at base and slightly curved, whereas all other segments are straight. On the inner surface of the scape, there is one twisted trichobothrium and three thick large socketed trichoid sensilla with grooved surface (st I, plate fig. 50B). Similar sensilla occur elsewhere on this segment (especially on its median surface) as well as on pedicel, along with another type of trichoid sensilla that are much smaller, have a smooth surface and slightly hooked point (st II, plate fig. 50D). The first flagellomere carries the trichoid sensilla of the same two types as on scape and pedicel. The terminal flagellomere has a thin pre-segment on its base (plate fig. 50C). It carries the basiconic sensilla with hooked points that remind very much of st II (plate fig. 50D), except for lack of a socket and porose surface (sbp in plate fig. 50C), and in addition erect socketed trichoid sensilla with porose surface (st III, plate fig. 51B), quite large number of short basiconic sensilla with grooved tips (sbg, plate fig. 51C) and also a number of coeloconic sensilla (at least 2 different types, plate fig. 51D-E).

Labium tip

Sternorrhyncha. In *Psylla alni*, the labium tip is acute and carries 4 basiconic sensilla on each side: one on the very tip and three surrounding the first in a broader circle (plate fig. 52). The surface of basiconic sensilla appeared smooth and without pores at larger magnifications (plate fig. 52B). Orientation of mandibular stylets within the labium (i.e. if there was a twist or not) could not be observed. Antisuturally, there is a fissure that reaches back some way along the labium.

Cicadomorpha. In *Cercopis sanguinolenta*, the tip of the labium is lipped, with the elevated median parts surrounding the stylet bundle (plate fig. 53B). The parts immediately touching the stylets carry multi-peg structures similar (and probably homologous) to those found e.g. in Gerromorpha (Brożek & Zettel, 2014) (plate figs. 53, 54A). Form and orientation of the stylet bundle could not be assessed. The sensilla of the labium tip are assembled in several groups (plate fig. 53A). On both left and right half there is a group of trichoid sensilla on the sutural side (subdivided into two subgroups, 4 sensilla in each) that is set off above the labium tip margin (plate fig. 53B). Most of them are quite tall and have finely porose surface (plate fig. 54B, C), whereas one is blunt and has two large pores on the tip (number 5 in the plate fig. 54B). The cuticle that carries the sutural group is sculptured. The sutural group of sensilla is surrounded on the periphery by a half-circle of 5 large and one small smooth socketed trichoid sensillum (plate fig. 54F). Centrally, there is a smooth socketed trichoid sensillum close to the sutural end of the multi-peg structure (plate fig. 54E); antisuturally, there are two large and one small smooth socketed trichoid sensilla (plate fig. 54D).

In *Cicadella viridis*, the tip of the labium is skewed antisuturally (plate fig. 55B), similar to the condition in some Peloridiidae. The parts embracing the stylets carry multi-peg strictures (plate figs. 55A, 56D). The maxillae of the stylet bundle are not rotated (plate fig. 56D); the mandibles could not be observed. On the labium tip itself there are several types of sensilla which are all arranged closer to the periphery. Suturally, there is a large group of 7-8 basiconic sensilla that are accompanied by one or two trichoid ones (plate fig. 55A). The basiconic sensilla can be divided in two types: sb1 are larger and smooth, with a tip of somewhat irregular form (plate fig. 56B); sb2, which is only present in one specimen, much smaller, conical, with a one terminal pore and two pores on the base (plate fig. 56C). Trichoid sensilla can be divided into three types by their size; the surface is smooth in all cases, for st1 and st3 a moulting pore on the base could be observed (s. plate fig. 56A). The tip of the labium in *C. viridis* also carries pores (plate fig. 55B). The central part of the tip is set off higher than its periphery; cuticula of the tip is not sculptured.

Fulgoromorpha. In *Laodelphax striatella*, the end of the labium is thickened, reminding a mushroom cap in sutural view (plate fig. 57A). This “cap” is a cone with a broad flat tip that carries sensilla. On each side, there is a large sutural group of 9 trichoid (all socketed, although quite low), 1 placoid and 1 coeloconic sensilla (plate fig. 58A) that are located on a cuticular eleveation, and one antisutural multiporous basiconic sensillum (sb, plate fig. 58B). A cuticular fold connects it with the sutural group of sensilla. The antisutural margin of the stylet opening is projected into a triangular process bordered by a cuticular fold (plate fig. 58B) that seems to carry a small placoid sensillum with a central pore (spla? in plate fig. 58B). The trichoid sensilla in the sutural group can be divided into 4 types. st 1 (plate fig. 58A) is the smallest one and occurs only once; st2 is present in 4 copies (plate fig. 58A) and seems to possess a complicated tip structure (plate fig. 58C). Then, there are two st3

that are larger than other sensilla (plate fig. 58A) and seem to possess a terminal pore (plate fig. 58C). Finally, there are two st4 (plate fig. 58A) that are characterized by an especially long and twisted tip (plate fig. 58D) and probably a subterminal pore (plate fig. 58A). Last but not least, there is a multiporous placoid sensillum in the sutural group (plate fig. 58A, D). Cuticle regions bearing sensilla of the labium tip are not sculptured.

The labium tip of *Issus coleoptratus* is flat; the mandibular stylets are not twisted (plate fig. 59A, B). There is a wide circle of socketed trichoid sensilla with smooth surface that surround the tip on the periphery (st, plate fig. 59B, 60E). In the proximity of the labium orifice on the antisutural side there is a pair of basiconic sensilla, the two sensilla in the pair being quite different and therefore designated to different types (sb 3 and 4 in plate figs. 59B, 60D); surface details of their structure do not allow any conclusions on their function. Most sensilla are concentrated in a group that is located on a sculptured region of cuticula in the sutural region of the labium tip that is also set off somewhat lower than the rest of the tip. Here, two types of sensilla can be discerned. Basiconic sensilla of the type 1 ("*" in the plate figs. 59B, 60A) are low, conical, with finely porose surface and a complicated tip structure that suggest a pore complex (plate fig. 60A-B). Basiconic sensilla of type 2 ("+" in the plate figs. 59B, 60A) are higher, with smooth surface (plate fig. 60A, C) but also with something like a pore complex on the tip. It must be mentioned that the type 2 sensilla can vary significantly in length and the outline of the tip (compare e.g. both sensilla in plate fig. 60A or in plate fig. 60C) and in secretion that may stick to them (not shown) or be absent. However, these differences were not stable among the homologous sensilla in specimens that were pre-treated with different methods and need to be studied more, so for now no subtypes are discerned within the type 2.

Heteroptera. In *Ceratocombus sp.*, the labium is long, thin and its tip is pointed (plate fig. 61). Mandibles are toothed and not twisted (plate fig. 61B). A peculiar feature is the antisutural apical plate (*sensu* Cobben, 1978, p. 91.) visible in plate fig. 62A, which makes the labium tip tripartite. The sensilla are not trichoid or basiconic, but are all more or less elevated placoid ones: a large oblong sensillum with multiple pores in the middle (cps, "central placoid sensillum" in plate fig. 62) and 9 small ones surrounding it in a wide circle. The 5 of those that are lying more centrally (numbered 1, 2, 3, 8, 9 in the plate fig. 62) seem to have a large pore in the middle, whereas the 4 located laterally (nr. 4, 5, 6, 7) are more cupola-shaped with no clear central pore. The central placoid sensillum is most likely built by very delicate cuticle, since in cases when the specimens were not critically-point dryed but slowly air-dried, the sensillum appeared imploded (data not shown).

The labium of *Saldula saltatoria* is, as in *Ceratocombus*, long, thin and sharply pointed. Mandibles are toothed and not twisted (plate fig. 63A); maxillae are fringed (plate fig. 63A). Small trichoid sensilla on the ventral and lateral surface of the labium are located in cuticular folds (plate fig. 63B). The apical region on each side is bordered by a semicircular cuticular fold and 5 small placoid sensilla with central pores are located within it (marked with asterisks in plate fig. 63 C, D). On the apical region itself, there are 5 more placoid sensilla with a central pore (asterisks in the plate fig. 63 C-D), one coeloconic ("+" in the plate fig. 63D) and one oblong placoid sensillum (pso = placoid sensillum oblong, in the plate fig. 63D). This sensillum has a surface with many fine pores (plate fig. 64B). An apical plate on the antisutural side is absent (plate fig. 64A), but the last labial segment has a fissure not only on the sutural, but also on the antisutural side (plate fig. 64A).

The tip of the labium in *Corythucha ciliata* is not sharply pointed, but clearly skewed antisuturally (plate fig. 65A); on the same side there is also a fissure that stretches somewhat back along the segment (plate fig. 65B). Maxillar stylets are twisted at some 90° (plate fig. 65 A-B, where the border between the maxillae is seen laterally); one of the maxillae is longer and builds a cap over the other (plate fig. 65A). At the median margin of the labium opening there is a structure that reminds of the multi-peg structure in Cicadomorpha or *S.saltatoria*, although only 3 small pegs are seen (plate fig. 66B). The tip of the labium bears 13 sensory structures: 12 basiconic sensilla of variable size and a stellar folded structure that might be a sensillum or a gland (plate fig. 66A). The periphery of the labium tip carries a semicircle of 6 longer basiconic sensilla (numbered in plate fig. 65B); there is also a semicircle of small basiconic sensilla around the stellar structure (plate figs. 65B, 66A), and finally there are 3 more small basiconic sensilla surrounding the stylet opening (plate figs. 65B, 66B). All the basiconic sensilla seem to have a smooth surface without pores (plate fig. 66).

In *Pyrrhocoris apterus*, the labium tip is broad and flat (plate fig. 67A). Stylets are not twisted (plate fig. 67B). There are 4 trichoid sensilla surrounding the labium tip on the periphery. Then, there are 12 basiconic sensilla of three different types, concentrated in a sutural group (plate figs. 67B, 68A). 9 of the basiconic sensilla bear several small pores close to the tip and one large terminal pore (plate fig. 68B), (sbp in the plate fig. 68 = sensilla basiconica, porose). They appear somewhat deflated in plate figs. 67B and 68, but this might be an artefact, since in other specimens they had normal appearance (data not shown). 1 basiconic sensillum is clearly smaller than the 9 sbp, being similar in other parameters (sbps = sensillum basiconicum porose, small in plate fig. 68A); it appears to have a large pore. In addition, there are two sensilla that appear similar to the double-walled type (Altner & Prillinger, 1980) and are termed sb-dw, “sensilla basiconica, double-walled” (plate fig. 68A, B).

3.3.2.2 Characters of the thorax

Surface sculpture on tegmina

In hemipterans other than Peloridiidae, the surface sculpture never reaches such diversity. Another difference is that the structural elements dorsally and ventrally are mostly the same, in contrast to the moss bugs, whose ventral and dorsal surfaces of the tegmina in most cases look strikingly different.

Sternorrhyncha. On the ventral side of the tegmen in *Psylla alni*, there are sensory hairs and finger-like microtrichia along the veins and knob-like between the veins (plate fig. 69). The sculptural elements are not dense. Dorsally, knob- or finger-like elements are present on marginal regions among the veins, whereas the veins carry some finger-like elements.

Cicadomorpha. In *Cercopis sanguinolenta*, the ventral side of the tegmen carries a plenty of sensory hairs (plate fig. 70); along the veins, small knob-like sculptural elements and integumental glands can be found (plate fig. 70b, above left). Dorsally, the sensory hairs grow more densely, sculptural elements are not seen and integumental glands occur throughout the surface. In *Cicadella viridis* there are finger-like or teeth-like microtrichia all over the ventral tegminal surface (plate fig. 71);

brochosomes (nanoscopic bodies produced in Malpighian tubules and applied by the insect to the body; Rakitov, 2002) are very common and can reach high densities. Dorsally, the tegmina of *Cicadella viridis* carry no microtrichia, but some sensory hairs and numerous integumental glands located in cuticular depressions; brochosomes are common, too.

Fulgoromorpha. In *Laodelphax striatella*, the veins carry ventrally small teeth-like elements that also may occur among the veins, especially on the distal region of the tegmen (plate fig. 72). Light wax-like cover (removebale by incubation in chloroform) is visible on the ventral surface. Dorsally, there are only sensory hairs inserting on the veins, sculptural elements lacking completely. In *Issus coleoptratus* (plate fig. 73), the ventral surface of the tegmen is densely and uniformly covered with small knob-like sculptural elements (although its density and dispersal might vary individually); these elements are covered with wax-like secretion that is removed by incubation in chloroform. Dorsally, there are only sensory hairs of low density.

Heteroptera. In *Ceratocombus* sp., the tegmina (both ventrally and dorsally) are densely and uniformly covered by hair-like microtrichia (plate fig. 74). On the dorsal side, there are also large sensory hairs, occurring mostly on the tegmen margin or sometimes on veins. In *Saldula saltatoria*, the tegmen is densely and uniformly covered ventrally by hair-like microtrichia (plate fig. 75). Some trichoid sensilla are present along the costal vein. Dorsally, the microtrichia cover is the same, but there is also a bare spot on the tegmen base around the median vein, and trichoid sensilla are abundant on all of the corium as well as on the veins in the membrane. In *Corythucha ciliata*, there are small hair-like microtrichia along the veins ventrally; in the regions between the veins the microtrichia occur only on the parts around R that are inflated bladder-like on the dorsal side (plate fig. 76). It is worth noting that in another tingid, *Dictyla humuli*, hair-like microtrichia occur all over the ventral surface of the tegmen. Dorsally, the veins of *Corythucha* are covered by very small knob-like microtrichia and sporadically occurring large teeth-like acanthae (plate fig. 76d). These are especially common on the inflated bladder-like region; here, the microtrichia occur not only on, but also between the veins. In *Pyrrhocoris apterus* (plate fig. 77), the ventral side of the tegmen is uniformly covered by small knob-like elements, only the claval suture is bare of them and smooth. Dorsally, there are the same knob-like elements that are as common and uniformly spread as ventrally, but trichoid sensilla occur as well.

Distal hind leg.

Sternorrhyncha. In *Psylla alni* (plate fig. 78), the distal hind tibia bears 7 spurs, and the proximal segment of the tarsus carries two (plate fig. 78a). The tarsi are two-segmented. There is an inflatable membranous region between the spurs on the ventral side of this first tarsal segment (plate fig. 78a, b). Claws of the pretarsus do not bear setae but are covered in microtrichia. Each claw carries a fleshy (but not significantly inflatable) pulvillum that is attached to its inner/dorsal side; pulvilli possess large contact zones (sensu Friedemann & Beutel, 2014). The unguitractor has only two scales and carries two long setiform socketed parempodia.

Cicadomorpha. Distal tibiae of both *Cercopis sanguinolenta* and *Cicadella viridis* (plate figs. 79 and 80) carry setae that are set in large robust sockets. These sockets in *C. sanguinolenta* are 15 in

number, immobile and resemble tibial spurs of *Psylla alni* or Peloridiidae; the setae that they bear are thin (plate fig. 79). In *C. viridis*, the 4 sockets appear to be moveable and the setae that they bear are almost as thick as the sockets themselves and robust (plate fig. 80). Both species have 3-segmented tarsi. Claws in *C. sanguinolenta* bear setae basally (10 per claw), whereas claws in *C. viridis* only carry microtrichia. There are also ventral setae on arolium (3 pairs in both *C. sangionolenta* and *C. viridis*). Arolium setae of *C. viridis* are carried on membranous parts and in *C. sanguinolenta* on sclerites. *C. sanguinolenta* also possesses a protrusion on the arolium that is in close contact with the claw tip (plate fig. 79, see also Friedemann et al., 2014); arolium itself is well developed, surpassing in fully inflated condition the tips of the claws. In *C. viridis* it is bilobed; in *C. sanguinolenta* it has a single lobe and the median incision cited by Friedemann et al. (2014) was not observed in a fully inflated condition (s. plate fig. 79c). Large contact zone (or zones in case of bilobed arolium) is developed in both species. Arolium in Cicadomorpha is largely membranous and inflatable. The unguitractor bears numerous rounded scales that are not organized in rows. On the ventral side of the distal end of the last tarsal segment, there is a small membranous flap that is stretched towards the unguitractor (e.g. plate fig. 79c).

Fulgoromorpha. In both representatives of this taxon in this study there are spurs on the distal tibia (10 in *Issus coleoptratus*, 5 in *Laodelphax striatella*, plate figs. 81 and 82); similar spurs (sometimes along with socketed setae) also exist on the two proximal tarsal segments (as Chen and Yang, 1995 mention, these structures appear already in larval instars, sometimes very young ones). The tarsi are 3-segmented in both species. There are setae on the basis of each claw (three per claw in *I. coleoptratus* and one per claw in *L. striatella*). Arolium carries one pair of setae in *I. coleoptratus*, but two in *L. striatella*. The unguitractor bears numerous scales organized in 2 longitudinal rows (*L. striatella*), or without recognizable rows (*I. coleoptratus*); the scales are rectangular in *L. striatella* and rounded in *I. coleoptratus*. The arolium has a single lobe in both species; in *I. coleoptratus* it possesses a large membranous part, is inflatable and in this condition surpasses the tips of the claws (plate fig. 82c), whereas it is not significantly inflatable in *L. striatella* and does not reach the tips of the claws by far. A large contact zone is recognizable in the arolium of *I. coleoptratus*, but not in *L. striatella*. As in Cicadomorpha, there is a membranous ventral flap on the distal ventral end of the last tarsal segment.

Heteroptera. No true bug species in the present study possessed spurs on the distal tibia, only strong robust setae (plate figs. 83-86). The hind tarsi are 3-segmented in *Saldula saltatoria* and *Pyrrhocoris apterus* and 2-segmented in *Ceratocombus* sp. and *Corythucha ciliata*. No species possessed arolia. *P. apterus* was the only species in our analysis to carry pulvilli. As for parempodia, they are present in *S. saltatoria* (4 small unsocketed protuberances), *C. ciliata* (2 socketed setae + 2 unsocketed protuberances) and *P. apterus* (2 long socketed setae + 2 unsocketed protuberances). *Ceratocombus* sp. possesses minute protuberances on the distal unguitractor, which are interpreted as parempodia by Friedemann et al. (2014). The empodium in most of the studied heteropterans has a simple form, whereas in *P. apterus* it is divided by a median depression. The unguitractor bears on each side a longitudinal row of scales: 6-8 in *Ceratocombus*, 5 in *C. ciliata* and 11 in *P. apterus*; the exact number in *S. saltatoria* was not possible to assess (but it is likely around 12). A median row is sometimes also present: it has 3 (*S. saltatoria*, *C. ciliata*) or 7 scales (*P. apterus*); in *S saltatoria*, there are rows of microtrichia istead of scales (plate fig. 84) and only *Ceratocombus sp*. does not have any median elements at all. The number of scales in lateral rows is thus ca. twice the number of the scales in the

median row. The scales are large, broad and rectangular, or almost rectangular in form. Claws in *Ceratocombus* are sculptured with microtrichia (plate fig. 83c); in *C. ciliata*, they carry a large basal tooth (plate fig. 85c-d). The empodium, or the distal part of the unguitractor plate, has simple form in all species studied, except for *P. apterus* where it is divided distally by a median depression (plate fig. 86). The ventral distal margin of the last tarsal segment is concave or incised in all heteropteran species in our study, except *C. ciliata* where it is elevated in a sclerotized flap covering the basal region of the unguitractor (plate fig. 85c). The distal margin of the distal tarsal segment in *P. apterus* (plate fig. 86c) carries a row of microtrichia (termed here "ventral brush" after Weirauch (2005) and Friedemann et al. (2014).

3.3.2.3 Characters of the abdomen

Surface of the dorsal abdomen

Sternorrhyncha. In *Psylla alni,* (plate fig. 87) dorsal surface of abdomen and thorax carries microtrichia that are covered by wax-like secretion that can be removed by chloroform (a well-known dewaxing agent, e.g. Hartung et al., 2016). The microtrichia are located on abdominal and posterior thoracal tergites.

Cicadomorpha. Dorsal surface of the abdomen in *Cercopis sanguinolenta* is almost bare of microtrichia and does not have a wax covering (plate fig. 88); in *Cicadella viridis,* the abdomen carries dorsally grouped (but sparse) microtrichia and is densely covered by brochosomes (as is the rest of the body) (plate fig. 89).

Fulgoromorpha. Both in *Laodelphax striatella* and *Issus coleoptratus*, microtrichia are common on the abdominal tergites and covered by a wax-like secretion that can be removed by chloroform (plate figs. 90-91).

Heteroptera. In all 4 heteropteran species studied, abdomen tergites carry microtrichia that can be setae-like (*Ceratocombus sp., Saldula saltatoria*) or peg- and bump-like (*Corythucha ciliata, Pyrrhocoris apterus*). None of the 4 species was found to possess waxy secretion, on abdominal tergites or elsewhere (plate figs. 92-95).

3.3.2.4 Characters of the general body surface

Integumental glands

Sternorrhyncha. In *Psylla alni*, no integumental glands were observed, not even simple pores in cuticula.

Cicadomorpha. In *Cercopis sanguinolenta*, the structures that we recognize as glands (concerning our interpretation in this and other auchenorrhynchan species s. the Discussion, chapter 4.1.2.5.) are numerous and can be found everywhere on the body – on head, thorax, dorsal abdomen and tegmina (plate fig. 96). They have the appearance of round deep depressions (ca. 3 µm in diameter) in cuticula with several finger-like concentric peripheral elements that are arranged in a circle. The elements start more or less flat on the periphery and join each other and become almost erect in the center (plate fig. 96B). Some simple pores in the cuticula were also observed.

Cicadella viridis seems to have glands of several different types that nevertheless can have intermiediate morphology. In the first type, (plate fig. 97A, B) its concentric elements are not finger-like and do not become erect towards the center, reminding more of flat bars that can be somewhat irregular in form. The second type differs from the first by the concentric bars being more regular and flat (may appear as triangular teeth surrounding the gland opening) and the margin of the gland sometimes being elevated (plate fig. 97A, II). The third type (plate fig. 97C) resembles the glands of *C. snaguinolenta*. Glands of the fourth types are found on the abdominal terga and have finger-like peripheral elements that sometimes are even differentiated into outer and inner circle (plate fig. 97D). The last but not least, simple pores in the cuticula (plate fig. 97A) also occur in *C. viridis*.

Fulgoromorpha. In *Laodelphax striatella*, the integumental glands have the appearance of an oval-shaped cuticular field covered by very short bump-like microtrichia that surround a large (up to 1 µm) opening in the center (plate fig. 98) The glands are mostly found on the abdominal tergites; simple gland pores occur everywhere, they might be responsible for wax secretion, since in some cases pores with wax-like filaments sticking outside were observed. In *Issus coleoptratus*, the glands are simple openings sunk-in into a funnel-like depression; they occur almost everywhere on the body and are responsible for secretion of wax (plate fig. 99). Two claps that form the opening are sometimes visible on the bottom of the gland funnel, although it is not quite clear how regular this feature is. Surprisingly, the glands on abdominal tergites in specimens not dewaxed with chloroform are surrounded by a patch of wax-freee cuticula whereas all the rest bears wax cover – the picture being reversed in the specimens dewaxed with chloroform, where only the glands and their immediate surroundings have wax cover (plate fig. 100). Larvae carry on their abdominal terga round glands with a broad round central element (plate fig. 101); their homology to the glands in adults is likely, but unclear, as is their role.

Heteroptera. In *Ceratocombus* sp., the glands are very few and have a central pore that is surrounded by several very small peg-like peripheral elements arranged in a circle (plate fig. 102A). In *Saldula saltatoria*, the glands are also rare and have the appearance of several microtrichia sunken into a circular depression of the cuticula (plate fig. 102B); simple pores can also be found and are rare, too. *Corythucha ciliata* carries large glands on some abdominal and thoracal tergites. The structures are often more than 10 µm in diameter; small peg-like peripheral elements are grouped around a large central pore and surrounded by an elevated cuticular border (plate fig. 103 A, B). This species also possess simple cuticular pores that are quite common on different body regions. In *Pyrrhocoris apterus*, only such simple pores were found (plate fig. 103C).

3.4 Character coding for phylogenetic analysis

Based on the results of scanning electron microscopic study (Results, section 3.3.), the following characters were established and used for phylogenetic analysis of Peloridiidae and their sister groups. The characters are numbered from zero on, since this is the format that is used by the phylogenetic software WinClada (Nixon, 1999) that was used for construction of the character matrix. The character matrix with all taxa is presented after the character list. "-" in the matrix means that the character is inapplicable to the taxon, "?" – that the character state is missing. Supplement 3. is aimed to illustrate most of the character states in every peloridiid species under study. Characters are assembled in character complexes (such as tarsus, antenna etc.), but the complexes are not given in any particular order.

Tarsus

0. Number of tarsal segments: 0 = 2 segments, 1 = 3 segments

1. Tibial spurs: 0 = absent; 1 = present, not forming sockets for setae; 2 = present, forming sockets for setae

   Since the spurs are quite large in most groups, they are probably neither microtrichia nor acanthae, but multicellular structures. This view is somewhat supported by the ontogenesis of the tibial spurs in Peloridiidae, where all larval instars only carry socketed setae on distal tibia (that are likely homologues of the tibial spurs in adults), and setae are generated by three cells (Richards & Richards, 1979).

2. Tibial spurs formed as sockets for setae: 0 = immovable, 1 = movable

3. Position of tibial spurs: 0 = symmetrical, 1 = asymmetrical

   This character is only applicable to the Peloridiidae with 4 tibial spurs (most common number within the family). Two states (in ventral view) are possible: symmetrical arrangement, with one spur laterally on each side and two ventrally (e.g. Supplement 3. Fig. 1. A, B) – or asymmetrical one, with one inner lateral, one ventral and two outer lateral spurs (e.g. Supplement 3. Fig. 1. F, G).

4. Spurs on tarsal segments: 0 = absent, 1 = present

5. Setae on tarsus: 0 = not arranged in rows, 1 = arranged in rows

6. Setae on tarsus: 0 = fluted, 1 = smooth

7. Form of the T1: tapered = 0, rounded = 1

   The character is applicable only to Peloridiidae

8. Ventral brush: 0 = absent, 1 = present

9. Ventral flap: 0 = absent; 1 = present, membranous; 2 = present, sclerotized

10. Arolium: 0 = absent, 1 = present

11. Arolium: 0 = single-lobed, 1 = bilobed

12. Protrusion on arolium: 0 = absent, 1 = present

13. Arolium (fully inflated) in comparison to claws: 0 = small, 1 = large

14. Contact zone on arolium: 0 = absent, 1 = present

15. Number of setae on the ventral side of arolium (one side): 0 = 1 setae, 1 = 2 setae, 2 = 3 setae

16. Pulvilli: 0 = absent, 1 = present

17. Form of the scales on the unguitractor: 0 = more or less rounded, 1 = more or less rectangular

18. Scales on unguitractor: 0 = not arranged in rows, 1 = arranged in rows.

    Psylla alni has only two scales on unguitractor, so this character is not quite applicable to the species

19. Number of rows of unfuitractor scales: 0 = 2 rows, 1 = 3 rows, 2 = 2 rows + microtrichia forming the middle row

20. The number of scales on unguitractor in lateral and median rows: 0 = similar, 1 = different (mostly the number in lateral rows is double that in the median row)

21. Setiform parempodia: 0 = absent, 1 = present

22. Accessory parempodia: 0 = absent, 1 = 1 pair, 2 = 2 pairs

23. Claws: 0 = smooth, 1 = sculptured with microtrichia, 2 = carry setae

24. Basal tooth on the claw: 0 = absent, 1 = present

25. Claws: 0 = not serrated, 1 = serrated

26. Microtrichia between claws and unguitractor: 0 = absent, 1 = present

Antennae

27. Ventral margin of the flagellum in caudal view: 0 = flat or almost flat, 1 = simply convex; 2 = convex, but with an offset tip being almost flat (s. Supplement 3. figs. 5-6)

28. Terminal placoid sensillum bordered by the furrow and coeloconic sensilla arranged in a more or less straight row = 0; not bordered by the furrow, coeloconic sensilla not in a row = 1

29. Scales on the flagellar petiolus: 0 = slender/weak, not touching each other; 1 = broad, touching each other; 2 = from slender to broad, variable

30. Scales on the fusiform part of the flagellum (ventral view): 0 = not extending into the apical third; 1 = extending into the apical third of the flagellum

31. Flagellum base: 0 = broad, 1 = petiolate

32. Sensilla numbers on the antenna: 0 = low, 1 = high

Low numbers mean at most couple of dozens, high – a hundred or more.

33. Campaniform sensilla on pedicel: 0 = absent, 1 = present

34. Olfactory placoid sensilla: 0 = absent, 1 = present

35. Coeloconic sensilla: 0 = absent, 1 = present

Genal area

36. Genal area: 0 = concave, 1 = flat

37. Genal area medially: 0 = covered with microtrichia, 1 = bare of microtrichia

38. Punctation on genal area: 0 = absent, 1 = present

39. Wax covering on genal area: 0 = absent, 1 = present

40. Hind margin of genal area: 0 = not convex, 1 = convex and reflexed, embracing somewhat the antenna

Dorsal abdomen

41. First abdominal tergite: 0 = long and narrow; 1 = short and thick

The width is measured as the longest distance between the arms of posterolateral cuticular apodemes on tergite 1. (Supplement 3., figs. 11-14)

42. Plastron: 0 = present on the whole of abdominal dorsum, 1 = lateral regions of anterior segment borders plastron-free, 2 = lateral regions of posterior segment borders plastron-free

43. Plastron-building microtrichia: 0 = small (2-3 µm), 1 = large (> 10 µm)

44. Microtrichia arrangements: 0 = single, 1 = single, in rows; 2 = single, but arranged in groups of several microtrichia that are aligned in rows; 3 = grouped, originating from a common base

45. Microtrichia on lateral regions of abdominal tergites: 0 = unorganized, 1 = tend to arrange in circles (cell borders?)

46. Microtrichia on abdominal tergites: 0 = sparse, 1 = dense

47. Microtrichia on abdominal tergites: 0 = peg- or knob-like, 1 = hair-like

48. Abdominal tergites: 0 = not covered with wax, 1 = covered with wax

Sculpture of tegmina

49. Ventral surface of the tegmina: 0 = mostly covered by cuticular sculpture; 1 = sculptural elements are sparse, limited to a very small part of the surface or completely absent

50. Ventral sculpture on tegmina: 0 = present only or mostly on veins, 1 = present on veins and membranous areas between them

51. Ventral sculpture on tegmina, ScP: 0 = not sculptured, 1 = sculptured

52. Ventral sculpture on tegmina: 0 = present mostly laterodistally of R and M, 1 = present on the most part of the tegmen, not only beyond R and M

53. Ventral sculpture on tegmina: 0 = absent on clavus, 1 = present on clavus

54. Ventral sculpture on tegmina: 0 = M + CuA with reduced sculpture, 1 = M + CuA with normal sculpture

55. Ventral sculpture on tegmina: 0 = CuP with reduced sculpture, 1 = CuP with normal sculpture

56. Ventral sculpture on tegmina: 0 = apical radial cell without a bare spot that is free of sculpture, 1 = apical radial cell has a bare spot

57. Ventral sculpture on tegmina: 0 = the bare spot on the apical radial cell is marginal, 1 = the bare spot of the apical radial cell reaches the center of the cell or even beyond

58. Ventral sculpture on tegmina, between ScA / ScP and/or on costal cells: 0 = sculpture absent, 1 = sculpture present

59. Ventral sculpture on tegmina: 0 = scale-like acanthae absent, 1 = scale-like acanthae present

60. Ventral sculpture on tegmina: 0 = peg-like microtrichia absent, 1 = peg-like microtrichia present

61. Ventral sculpture on tegmina: 0 = hair-like microtrichia absent, 1 = hair-like microtrichia present

62. Ventral sculpture on tegmina: 0 = “compressed scales” absent, 1 = “compressed scales” present

“Compressed scales” are depicted in the figure 20c

63. Ventral sculpture on tegmina (except C, ScP and costal cells): 0 = trichoid sensilla absent, 1 = trichoid sensilla present

64. Ventral sculpture on tegmina: 0 = sculpture on veins same as on membranes, 1 = sculpture on veins different to that on membranes

65. Dorsal sculpture on tegmina: 0 = microtrichia absent, 1 = microtrichia present

66. Dorsal sculpture on tegmina: 0 = microtrichia single or at most grouped by 2 or 3, quite sparse; 1 = microtrichia are assembled in larger groups, quite dense

67. Dorsal sculpture on tegmina: 0 = trichoid sensilla absent, 1 = trichoid sensilla present on veins, 2 = trichoid sensilla present on most of the tegmen surface

68. Dorsal sculpture on tegmina: 0 = punctation dorsally widespread, 1 = punctation limited to the R stem and AP; 2 = punctation is absent

Integumental glands

69. Integumental glands: 0 = simple glands absent, 1 = simple glands present

"Simple glands" are pores without peripheral elements or complicated orifice structures.

70. Integumental glands type III with peripheral elements: 0 = absent, 1 = present

71. Integumental glands: 0 = peripheral elements not differentiated; 1 = differentiated into inner and outer circle

In the last case the gland opening is often covered by the inner elements.

72. Integumental glands, orifice: 0 = not sunk sunk-in; 1 = sunk-in

When the orifice of the gland is sunk-in into the cuticle, the inner peripheral elements are mostly sunk-in, too.

73. Integumental glands, inner elements relative size: 0 = definitely smaller than the outer elements; 1 = not clearly smaller

74. Integumental glands, outer elements: 0 = without clubbed tip, 1 = with clubbed tip

75. Integumental glands, outer elements: 0 = their number (or the number of undifferentiated peripheral elements) does not vary with body region; 1 = the number varies with it

76. Integumental glands, on head and pronotum: 0 = glands on that regions are similar to those elsewhere on the body; 1 = glands on dorsal side of head and pronotum are set on cuticular elevations; 2 = glands on both dorsal and ventral side of head and pronotum are set on cuticular elevations; 3 = glands on head and pronotum are sunk-in into the cuticula

77. Integumental glands, individual variation: 0 = absent, 1 = present

78. Integumental glands, on abdominal terga: 0 = abdominal terga do not carry integumental glands; 1 = abdominal terga carry them

79. Integumental glands, on abdominal terga: 0 = absent from plastron regions; 1 = occur under plastron

80. Integumental glands, on abdominal terga: 0 = have structure similar to the glands elsewhere on the body; 1 = have structure different from them

Labium

81. Labium tip form: 0 = flat, 1 = skewed, 2 = lipped, 3 = sharp

82. Labium tip, antisutural fissure: 0 = absent, 1 = present

82. Labium tip, apical lobe: 0 = absent, 1 = present

84. Labium tip, multi-peg structures: 0 = absent, 1 = present

85. Labium tip, centro-antisutural part of the labium: 0 = not elevated, 1 = elevated

86. Labium tip, antisutural group of the sensilla on the margin of the labium orifice: 0 = absent, 1 = present

The inner trichoid sensilla in Peloridiidae are considered homologous to the antisutural group in Fulgoromorpha, since in many Peloridiidae they are located on the antisutural side of the labium orifice. In these representatives the mandibular stylets are not twisted, which is most likely a plesiomoprhous condition, when compared with the inner sensilla located laterally, where the mandibular sensilla are twisted.

87. Labium tip, outer circle of sensilla with (at least presumably) predominantly mechanosensitive function: 0 = absent, 1 = present

88. Labium tip, sutural group of mostly (presumably) gustatory sensilla: 0 = absent, 1 = present

89. Labium tip, cuticula carrying sutural group of sensilla: 0 = not sculptured, 1 = sculptured

90. Labium tip, multiporous (presumably olfactory) sensilla: 0 = absent, 1 = present

For Peloridiidae, even in cases when the coeloconic sensillum does seem to have only a terminal pore and not a multiporous wall, this character is coded as “present”, since the sensilla with a single pore are clearly homologous to the multiporous ones in other Peloridiidae.

91. Labium tip, inner trichoid sensilla: 0 = located antisuturally of the labium orifice, mandibular stylets not twisted; 1 = laterally of the labium orifice, mandibular stylets twisted

92. Labium tip, coeloconic sensilla: 0 = multiporous, 1 = terminal pore, 2 = socketed, with a terminal pore

*93. Acoustics, pulse frequency: 0 = low (under 10 Hz), 1 = high (20 Hz and above).

*94. Acoustics, echeme diversity: 0 = single echeme type, 1 = two and more echeme types

*95. Behaviour, males riding on backs of conspecifics: 0 = uncommon, 1 = common

(The last three characters marked with an asterisk are only used when discussing possible alternative implementations of behavioural characters for phylogenetic inference on Peloridiidae. All the

phylogenetic hypotheses presented in the next chapter are established with the matrix including only morphological characters, 0 to 92)

	0. number of tarsal segments	1. tibial spurs present/not	2. tibial spurs as setae sockets	3. position of tibial spurs	4. spurs on tarsal segments	5. setae on tarsus in rows/not	6. setae on tarsus fluted or smooth	7. form of T1 rounded or tapered	8. ventral brush present/not	9. ventral flap	10. arolium present/not	11. arolium single-/bilobed	12. protrusion on arolium	13. arolium vs. claws	14. contact zone on arolium	15. number of setae on arolium	16. pulvilli present/not
Psylla alni	0	1	-	-	1	1	0	-	0	0	0	-	-	-	-	-	1
Cercopis sanguinolenta	1	2	0	-	1	0	0	-	0	1	1	0	1	1	1	3	0
Cicadella viridis	1	2	1	-	1	1	0	-	0	1	1	1	0	1	1	3	0
Laodelphax striatella	1	1	-	-	1	1	0	-	0	1	1	0	0	0	0	2	0
Issus coleoptratus	1	1	-	-	1	0	0	-	0	1	1	0	0	1	1	1	0
***Ceratocombus* sp.**	0	0	-	-	0	0	0	-	0	0	0	-	-	-	-	-	0
Saldula saltatoria	1	0	-	-	0	0	0	-	0	0	0	-	-	-	-	-	0
Corythucha ciliata	0	0	-	-	0	1	1	-	0	2	0	-	-	-	-	-	0
Pyrrhocoris apterus	1	0	-	-	0	0	0	-	1	0	0	-	-	-	-	-	1
Hackeriella brachycephala	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Hackeriella echina	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Hackeriella veitchi	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Hemiodoecellus fidelis	0	1	-	-	0	1	1	0	0	0	1	0	0	0	0	1	0
Hemiodoecus acutus	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Hemiodoecus crassus	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	?	0
Hemiodoecus leai	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Hemiowoodwardia wilsoni	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Idophysa chonos	0	1	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Oiophysa ablusa	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Oiophysa cumberi	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Oiophysa distincta	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Pantinia darwini	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Peloridium hammoniorum	0	1	-	0	0	1	1	0	0	0	1	0	0	0	0	1	0
Peloridium pomponorum	0	1	-	0	0	1	1	0	0	0	1	0	0	0	0	1	0
Peloridora holdgatei	0	1	-	1	0	1	1	0	0	0	1	0	0	0	0	1	0
Xenophyes cascus	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Xenophyes kinlochensis	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Xenophyes rhachilophus	0	0	-	-	0	1	1	1	0	0	1	0	0	0	0	1	0
Xenophysella greensladeae	0	1	-	0	0	1	1	1	0	0	1	0	0	0	0	1	0
Xenophysella stewartensis	0	1	-	0	0	1	1	1	0	0	1	0	0	0	0	1	0

	17. scales on unguitractor form	18. scales on unguitractor in rows/not	19. rows of unguitractor scales	20. lateral/median rows unguitractor scales	21. setiform parempodia present/not	22. accessory parempodia	23. claw sculpture	24. basal tooth on the claw	25. claw serrated/not	26. microtrichia between claws/unguitractor	27. ventral margin flagellum	28. furrow & coeloconic sensilla row	29. scales flagellar petiolus	30. scales fusiform flagellum	31. flagellum base	32. antennal sensilla numbers
Psylla alni	-	-	-	-	1	0	1	0	0	1	-	-	-	-	0	0
Cercopis sanguinolenta	0	0	-	-	0	0	2	0	0	0	-	-	-	-	?	0
Cicadella viridis	0	0	-	-	0	0	1	0	0	0	-	-	-	-	1	0
Laodelphax striatella	1	1	0	-	0	0	2	0	0	0	-	-	-	-	1	1
Issus coleoptratus	0	0	-	-	0	0	2	0	1	1	-	-	-	-	1	1
***Ceratocombus* sp.**	1	1	0	-	0	1	0	0	1	0	-	-	-	-	1	1
Saldula saltatoria	1	1	2	-	0	2	0	0	0	0	-	-	-	-	0	1
Corythucha ciliata	1	1	1	1	1	1	0	1	0	0	-	-	-	-	0	1
Pyrrhocoris apterus	1	1	1	1	1	1	0	0	0	0	-	-	-	-	0	1
Hackeriella brachycephala	0	1	1	0	0	0	0	0	0	0	2	1	0	0	1	0
Hackeriella echina	0	1	1	0	0	0	0	0	0	0	2	1	1	0	1	0
Hackeriella veitchi	0	1	1	0	0	0	0	0	0	0	2	1	1	0	1	0
Hemiodoecellus fidelis	0	1	1	0	0	0	0	0	0	0	0	1	?	0	1	0
Hemiodoecus acutus	0	1	1	0	0	0	0	0	0	0	0	1	2	0	1	0
Hemiodoecus crassus	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0
Hemiodoecus leai	0	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0
Hemiowoodwardia wilsoni	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0
Idophysa chonos	0	1	1	0	0	0	0	0	0	?	1	1	0	0	1	0
Oiophysa ablusa	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	0
Oiophysa cumberi	0	1	1	0	0	0	0	0	0	1	1	1	0	0	1	0
Oiophysa distincta	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	0
Pantinia darwini	0	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0
Peloridium hammoniorum	0	1	1	0	0	0	0	0	0	1	1	0	1	1	1	0
Peloridium pomponorum	0	1	1	0	0	0	0	0	0	1	1	0	1	1	1	0
Peloridora holdgatei	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0
Xenophyes cascus	0	1	1	0	0	0	0	0	0	0	0	1	2	0	1	0
Xenophyes kinlochensis	0	1	1	0	0	0	0	0	0	0	0	1	2	0	1	0
Xenophyes rhachilophus	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0
Xenophysella greensladeae	0	1	1	0	0	0	0	0	0	?	2	1	1	1	1	0
Xenophysella stewartensis	0	1	1	0	0	0	0	0	0	0	2	1	1	1	1	0

	33. campaniform sensilla pedicel	34. olfactory placoid sensilla	35. coeloconic sensilla	36. genal area concave/flat	37. genal area medially m-trichia	38. genal area punctation	39. genal area wax	40. genal area hind margin	41. first abdominal tergite	42. plastron-free parts dorsum	43. plastron microtrichia size	44. plastron microtrichia arrang.	45. plastron microtrichia laterally	46. abd. microtrichia density	47. abd. microtrichia form	48. abd. wax cover
Psylla alni	0	0	1	-	-	-	-	-	-	-	-	-	-	1	0	1
Cercopis sanguinolenta	1	0	1	-	-	-	-	-	-	-	-	-	-	0	0	0
Cicadella viridis	1	0	0	-	-	-	-	-	-	-	-	-	-	0	0	0
Laodelphax striatella	1	1	1	-	-	-	-	-	-	-	-	-	-	1	0	1
Issus coleoptratus	1	1	1	-	-	-	-	-	-	-	-	-	-	1	0	1
***Ceratocombus* sp.**	0	0	0	-	-	-	-	-	-	-	-	-	-	1	1	0
Saldula saltatoria	0	0	0	-	-	-	-	-	-	-	-	-	-	1	1	0
Corythucha ciliata	0	0	0	-	-	-	-	-	-	-	-	-	-	0	0	0
Pyrrhocoris apterus	0	0	1	-	-	-	-	-	-	-	-	-	-	0	0	0
Hackeriella brachycephala	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1
Hackeriella echina	0	1	1	0	1	0	0	0	?	?	?	?	?	?	?	?
Hackeriella veitchi	0	1	1	0	1	0	0	0	?	0	0	0	0	1	0	1
Hemiodoecellus fidelis	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1
Hemiodoecus acutus	0	1	1	0	?	0	0	0	?	0	0	2	0	1	0	1
Hemiodoecus crassus	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1
Hemiodoecus leai	0	1	1	0	0	0	0	0	0	0	0	2	1	1	0	1
Hemiowoodwardia wilsoni	0	1	1	0	1	0	0	0	0	2	0	0	0	1	0	1
Idophysa chonos	0	1	1	1	0	0	0	0	?	0	1	-	-	1	0	1
Oiophysa ablusa	0	1	1	1	0	1	0	0	1	0	0	0	0	1	0	1
Oiophysa cumberi	0	1	1	1	1	1	0	0	1	0	0	0	0	1	0	1
Oiophysa distincta	0	1	1	1	0	1	0	0	1	0	0	0	0	1	0	1
Pantinia darwini	0	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1
Peloridium hammoniorum	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1
Peloridium pomponorum	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1
Peloridora holdgatei	0	1	1	0	0	0	0	0	-	1	0	0	0	1	0	1
Xenophyes cascus	0	1	1	1	?	0	0	0	1	0	0	1	0	1	0	1
Xenophyes kinlochensis	0	1	1	0	0	1	0	0	1	0	0	0	0	1	0	1
Xenophyes rhachilophus	0	1	1	1	0	1	0	0	1	0	0	0	0	1	0	1
Xenophysella greensladeae	0	1	1	1	0	1	0	0	1	0	0	3	0	1	0	1
Xenophysella stewartensis	0	1	1	1	0	1	0	0	1	0	0	3	0	1	0	1

	49. tegmen sculpture extent	50. tegmen sculpture veins/mem.	51. tegmen sculpture ScP	52. tegmen sculpture R-M	53. tegmen sculpture clavus	54. tegmen sculpture M + CuA	55. tegmen sculpture CuP	56. tegmen apical cell spot	57. tegmen apical cell spot form	58. tegmen sculpture ScA-ScP	59. tegmen sculpture scales	60. tegmen sculpture pegs	61. tegmen sculpture hairs	62. tegmen sculpture comp. scales	63. tegmen ventr. trichoid sens.	64. tegmen sculpture veins dif.
Psylla alni	-	-	-	-	-	-	-	-	-	-	0	1	0	0	1	-
Cercopis sanguinolenta	-	-	-	-	-	-	-	-	-	-	0	1	0	0	1	-
Cicadella viridis	-	-	-	-	-	-	-	-	-	-	0	1	0	0	0	-
Laodelphax striatella	-	-	-	-	-	-	-	-	-	-	0	1	0	0	0	-
Issus coleoptratus	-	-	-	-	-	-	-	-	-	-	0	1	0	0	0	-
***Ceratocombus* sp.**	-	-	-	-	-	-	-	-	-	-	0	0	1	0	0	-
Saldula saltatoria	-	-	-	-	-	-	-	-	-	-	0	0	1	0	0	-
Corythucha ciliata	-	-	-	-	-	-	-	-	-	-	0	0	1	0	0	-
Pyrrhocoris apterus	-	-	-	-	-	-	-	-	-	-	0	1	0	0	0	-
Hackeriella brachycephala	0	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1
Hackeriella echina	0	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1
Hackeriella veitchi	0	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1
Hemiodoecellus fidelis	0	0	0	1	-	0	1	-	-	0	1	0	0	0	0	0
Hemiodoecus acutus	0	1	0	1	1	0	1	1	0	0	1	0	0	0	0	0
Hemiodoecus crassus	0	1	0	1	1	0	1	0	-	0	1	0	0	1	0	1
Hemiodoecus leai	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0	0
Hemiowoodwardia wilsoni	0	1	1	1	1	0	1	1	0	0	1	1	0	1	0	1
Idophysa chonos	0	1	1	1	1	1	1	0	-	0	0	1	0	0	0	0
Oiophysa ablusa	0	1	1	0	-	0	1	0	-	1	1	1	0	0	0	1
Oiophysa cumberi	0	1	1	0	0	0	1	0	-	1	1	1	0	0	0	1
Oiophysa distincta	0	1	1	1	0	0	0	0	-	1	1	1	0	0	0	1
Pantinia darwini	0	1	0	1	0	0	0	0	-	0	1	1	0	0	0	1
Peloridium hammoniorum	1	-	-	-	-	-	-	-	-	-	0	1	0	-	0	1
Peloridium pomponorum	1	-	-	-	-	-	-	-	-	0	0	1	0	0	0	1
Peloridora holdgatei	0	1	1	1	1	1	1	0	-	0	0	1	0	0	0	0
Xenophyes cascus	0	1	1	1	1	1	1	0	-	0	1	0	0	0	0	0
Xenophyes kinlochensis	0	1	0	1	1	0	1	0	-	0	1	0	0	0	0	0
Xenophyes rhachilophus	0	1	1	1	1	0	0	0	-	1	1	0	0	0	0	0
Xenophysella greensladeae	0	1	0	1	1	0	0	0	-	0	1	0	0	0	0	0
Xenophysella stewartensis	0	1	0	1	1	1	1	0	-	0	1	0	0	0	0	0

	65. dors. tegmen microtrichia	66. dors. tegmen microtrich. dens.	67. dors. tegmen trichoid sens.	68. dors. tegmen punctation	69. glands simple	70. glands w. peripheral elements	71. glands p. el-ts differentiated	72. glands orifice sunk-in/not	73. glands inn. el-ts size	74. glands out. el-ts clubbed/not	75. glands el-ts body parts	76. glands head pronotum	77. glands individual variation	78. glands abd. terga	79. glands under plastron	80. glands abd. terga differ/not
Psylla alni	1	-	1	-	0	0	-	-	-	-	-	-	-	-	-	-
Cercopis sanguinolenta	0	-	2	-	1	1	0	1	-	-	-	-	-	1	-	0
Cicadella viridis	0	-	1	-	1	1	1	1	-	-	-	-	-	1	-	1
Laodelphax striatella	0	-	1	-	1	1	0	0	-	-	-	-	-	1	1	0
Issus coleoptratus	0	-	2	-	1	0	-	1	-	-	-	-	-	1	1	0
***Ceratocombus* sp.**	1	-	2	-	0	1	0	0	-	-	-	-	-	0	-	-
Saldula saltatoria	1	-	2	-	1	1	0	1	-	-	-	-	-	1	-	-
Corythucha ciliata	1	-	0	-	1	1	0	0	-	-	-	-	-	1	-	-
Pyrrhocoris apterus	1	-	2	-	1	0	-	-	-	-	-	-	-	1	-	-
Hackeriella brachycephala	0	-	1	0	1	1	0	0	-	0	0	0	0	0	-	-
Hackeriella echina	0	-	1	0	1	1	0	0	-	0	0	0	0	0	-	-
Hackeriella veitchi	0	-	1	0	1	1	0	0	-	0	0	0	0	0	-	-
Hemiodoecellus fidelis	0	-	1	0	1	1	0	0	-	0	0	1	0	0	-	-
Hemiodoecus acutus	0	-	1	0	1	1	0	0	-	1	0	0	0	0	-	-
Hemiodoecus crassus	0	-	1	0	1	1	1	0	0	1	1	0	0	0	-	-
Hemiodoecus leai	0	-	1	0	1	1	1	0	0	1	0	0	1	0	-	-
Hemiowoodwardia wilsoni	0	-	1	0	1	1	1	0	0	1	0	0	0	0	-	-
Idophysa chonos	0	-	1	0	1	1	1	1	0	0	0	0	-	0	-	-
Oiophysa ablusa	1	0	1	0	1	1	0	0	-	0	0	0	0	1	1	1
Oiophysa cumberi	1	1	1	0	?	1	1	0	0	0	0	0	0	1	1	0
Oiophysa distincta	0	-	1	0	1	1	1	0	0	0	0	0	0	1	1	0
Pantinia darwini	0	-	1	0	1	1	1	1	1	0	0	0	0	1	0	0
Peloridium hammoniorum	0	-	1	2	1	1	1	0	1	0	0	3	0	1	1	1
Peloridium pomponorum	0	-	1	2	1	1	1	0	1	0	0	3	0	1	1	0
Peloridora holdgatei	0	-	1	0	1	1	1	1	1	0	0	0	0	1	0	1
Xenophyes cascus	0	-	1	1	1	1	1	0	1	0	0	2	0	1	1	0
Xenophyes kinlochensis	0	-	1	1	1	1	1	0	1	0	0	0	0	1	1	1
Xenophyes rhachilophus	1	0	1	1	?	1	1	0	1	0	0	2	0	0	-	-
Xenophysella greensladeae	0	-	1	0	1	1	1	0	0	0	0	1	0	0	-	-
Xenophysella stewartensis	0	-	1	0	?	1	1	0	0	0	0	0	0	0	-	-

	81. labium tip form	82. labium tip fissure	83. labium tip apical lobe	84. labium tip multi-peg str.	85. labium tip center elevated	86. labium tip antisutural group	87. labium tip outer circle	88. labium tip sutural group	89. labium tip sutural group cuticle	90. labium tip mp-sensilla	91. labium tip inn. trichoid sensilla	92. labium tip coeloconic sensillum	*93. acoustic, pulse frequency	*94. acoustic, echeme types	*95. behaviour, males riding
Psylla alni	3	1	0	0	0	0	1	0	-	0	-	-	?	?	?
Cercopis sanguinolenta	2	0	0	1	1	0	1	1	1	1	-	-	1	1	
Cicadella viridis	1	0	0	1	1	0	1	1	0	0	-	-	?	?	?
Laodelphax striatella	0	0	0	0	1	1	0	1	0	1	-	-	1	1	?
Issus coleoptratus	0	0	0	0	1	1	1	1	1	1	-	-	?	?	?
***Ceratocombus* sp.**	3	0	1	0	0	0	0	1	0	1	-	-	?	?	?
Saldula saltatoria	3	1	0	1	0	0	0	1	0	1	-	-	?	?	?
Corythucha ciliata	1	1	0	1	0	0	0	1	0	0	-	-	1	0	?
Pyrrhocoris apterus	0	0	1	0	0	0	1	1	1	0	-	-	0	0	1
Hackeriella brachycephala	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hackeriella echina	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hackeriella veitchi	1	0	0	0	0	1	1	0	-	1	0	0	0	0	1
Hemiodoecellus fidelis	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hemiodoecus acutus	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hemiodoecus crassus	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hemiodoecus leai	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Hemiowoodwardia wilsoni	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Idophysa chonos	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Oiophysa ablusa	0	0	0	0	0	1	1	0	-	1	1	1	?	?	?
Oiophysa cumberi	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0
Oiophysa distincta	0	0	0	0	0	1	1	0	-	1	1	0	?	?	?
Pantinia darwini	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Peloridium hammoniorum	2	0	0	0	0	1	1	0	-	1	1	2	0	0	1
Peloridium pomponorum	2	0	0	0	0	1	1	0	-	1	1	2	0	0	1
Peloridora holdgatei	1	0	0	0	0	1	1	0	-	1	0	0	?	?	?
Xenophyes cascus	0	0	0	0	0	1	1	0	-	1	1	1	1	1	0
Xenophyes kinlochensis	0	0	0	0	0	1	1	0	-	1	1	0	?	?	?
Xenophyes rhachilophus	0	0	0	0	0	1	1	0	-	1	1	1	?	?	?
Xenophysella greensladeae	0	0	0	0	0	1	1	0	-	1	1	0	?	?	?
Xenophysella stewartensis	0	0	0	0	0	1	1	0	-	1	1	0	?	?	?

3.5 Phylogenetic analysis

Phylogenetic analysis of the matrix with 93 characters specified above delivered 6 equally parsimonious hypotheses (fig. 10).

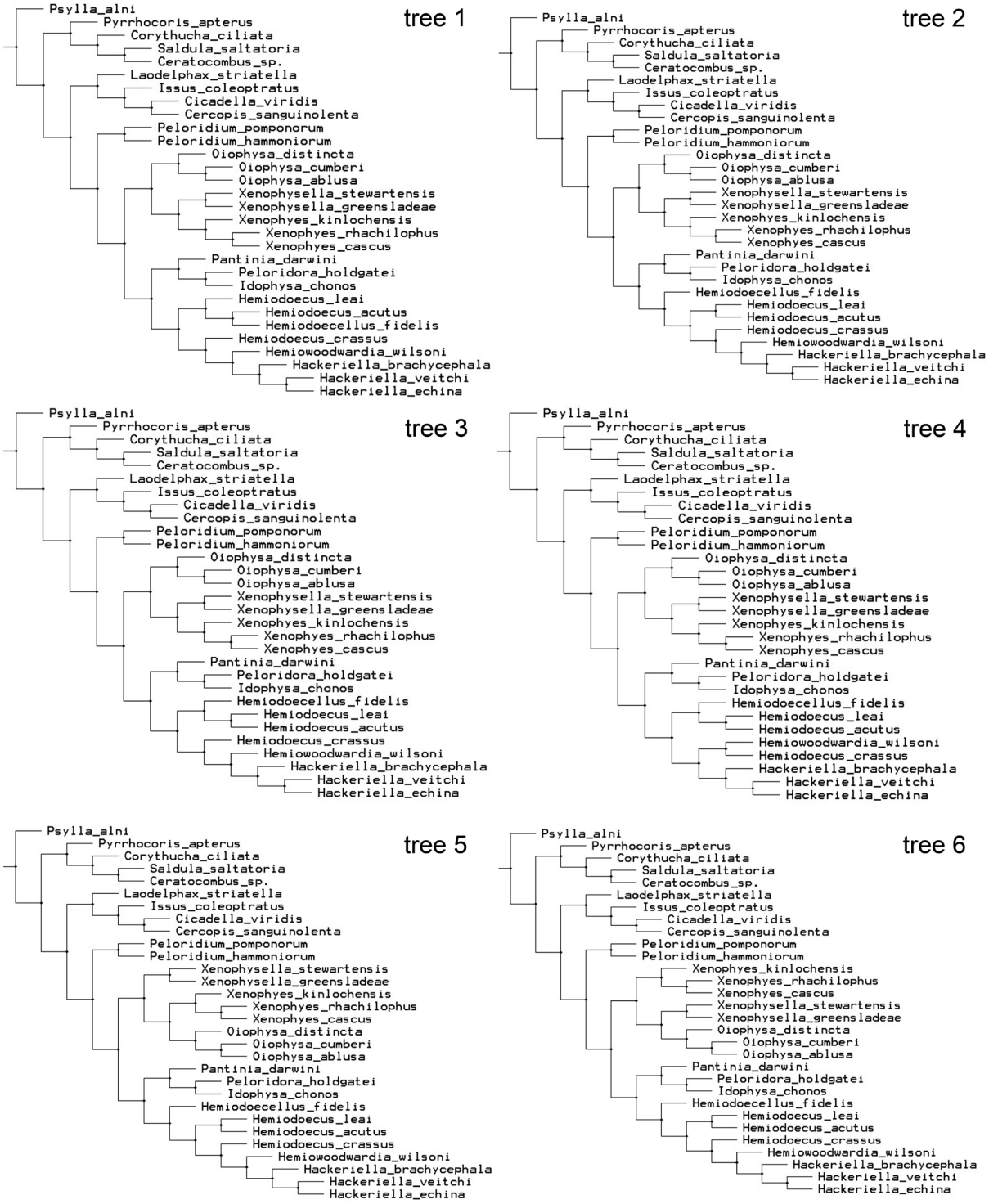

Figure 10. 6 equally parsimonious trees (length: 224), delivered by the analysis of the 93 character-matrix with TNT

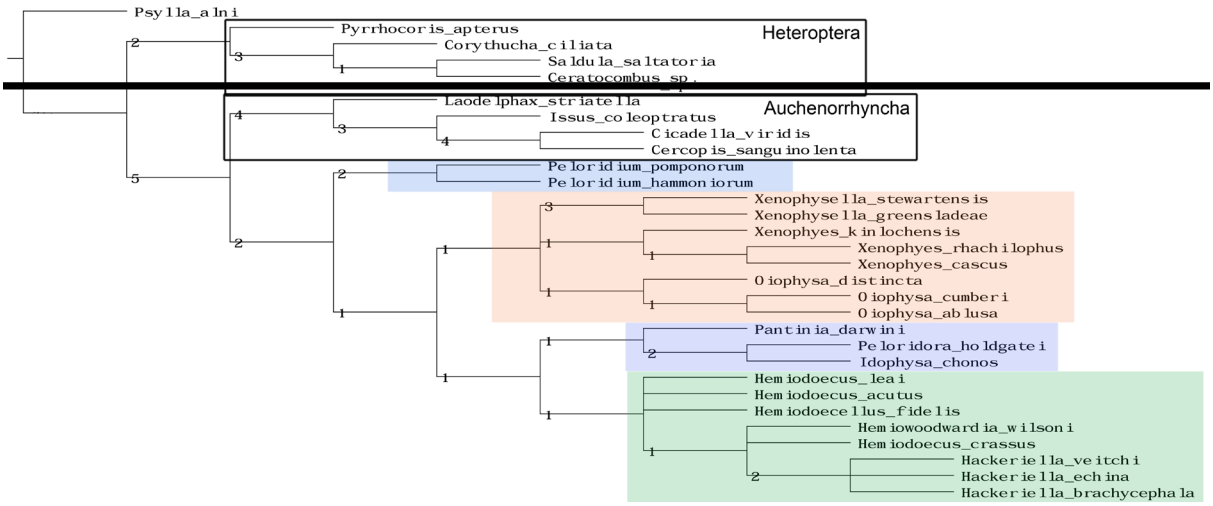

Figure 11. Strict consensus of the 6 trees from figure 10. Numbers on the nodes indicate Bremer support values; Ci = 49, Ri = 67, tree length = 228. Australian Peloridiidae are highlighted in green, South American in blue, New Zealand in red.

A strict consensus among the six trees delivered by TNT is presented in the figure 11. Heteroptera, Auchenorhyncha and Peloridiidae (= Coleorhyncha in the present study) are monophyletic; Auchenorrhyncha and Peloridiidae are sister groups and the monophylum that they build together has the strongest Bremer support value of all (5). Within the Peloridiidae, New Zealand representatives build a monophyletic clade (Bremer support = 1), as do the Australian species (Bremer support = 1). Representatives from South America are not monophyletic: the two *Peloridium* species constitute a monophylum that is sister group to all remaining Peloridiidae. The monophylum built by the rest of the species from South America (*Pantinia darwini*, *Peloridora holdgatei* and *Idophysa chonos*) is sister to the Australian clade (fig. 11). All genera of Peloridiidae are monophyletic, except the Australian *Hemiodoecus* that is paraphyletic, with some species closer related to *Hackeriella*.

One of the most parsimonious trees from figure 10 is presented in the figure 12, with apomorphies on the respective nodes and statistic support values. This phylogenetic hypothesis and other equally parsimonious ones are discussed in the Discussion, section 4.4.

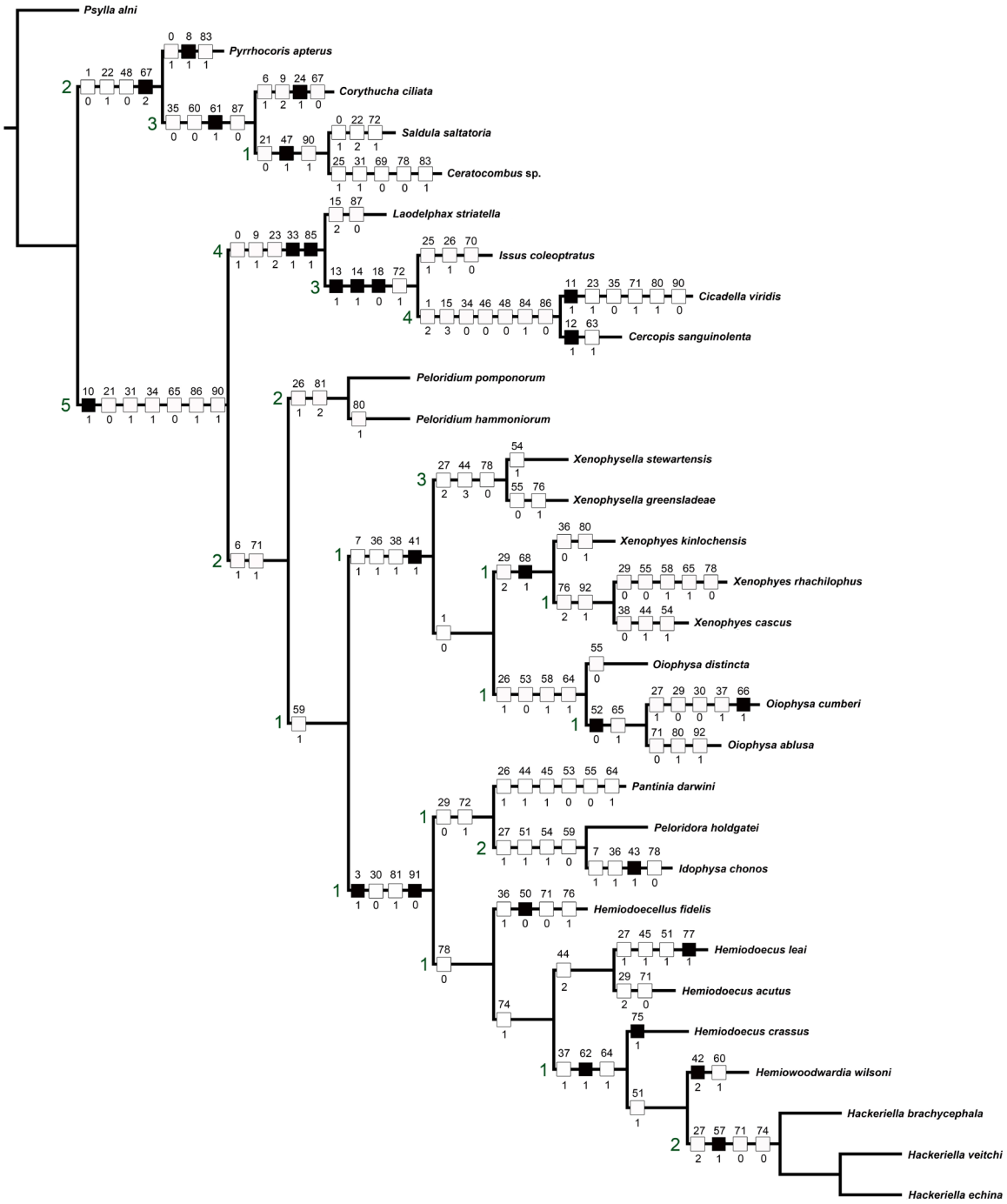

Figure 12. Tree 5 (from figure 10.) with apomorphies plotted on the respective branches. Empty squares are homoplasious characters, full squares non-homoplasious. The number above the square is the character number (Character matrix, section 3.4.), the number below is the character state. Large green numbers at some nodes indicate Bremer support values (taken from the consensus tree, figure 11). Tree length = 224, Ci = 50, Ri = 68.

3.6 Intraspecific communication

Oiophysa cumberi

The signal of the New Zealand *O. cumberi* includes several echeme types (fig. 13; table 1). Type A is a trill whose first pulse is the strongest one, followed by a train of pulses that grow weaker and weaker and slowly fade away. Its average length is 1,78 seconds, average number of pulses – 32, and average pulse frequency – 19 Hz (fig. 13A). Type B is a single pulse (fig. 13B). Type C has the most complicated structure: it begins as the echeme of the type 1, but at the moment where type A would fade away, type C is becoming stronger and louder again and remains at the same level of intensity for several seconds before ending abruptly. Average length of this type is ca. 6,9 s., average number of pulses is 170 and average pulse frequency is 20 (in the beginning) and 29 Hz (in the end) (fig. 13C). Type D is always occuring after the type C and is a sort of its "trailer": several pulses of high frequency ending abruptly; in most cases, there was only one echeme of this type occurring at once; rarely, there were two. Average length: 0,063 s., average number of pulses: 4, average frequency: 62 Hz (fig. 13D).

The call of the species consists of 8.7 echemes in average, always starting with the type A, which is the most common type. Two or three type A echemes are interspersed by single type B or D echemes (fig. 13). In the end of the call, there is a type C echeme that is followed by one-two type D echemes closely after. The average duration of the call is ca. 66 seconds, the average length of the pause between two calls – 22,5 seconds.

Vibrational calls are not pure tones, and the signals of *O. cumberi* are no exception. They are built by numerous harmonics (fig. 13, coloured spectrograms) that occur in the frequency area between 200 and 1200-1300 Hz (and in some cases, as in echemes of the D type that are more energetic and have also a higher frequency, even extend as far as 2000 Hz). Quite remarkable is the loss of amplitude occurring between the frequencies 400-500 Hz, especially well seen in spectrograms 13A and 13C as a greenish-yellowish area of lower signal amplitudes between two reddish areas of higher amplitudes (200-400 Hz and 500-1200 Hz).

	echeme type A	**echeme type B**	**echeme type C**	**echeme type D**
duration, sec	1,595; 1,481; 1,81; 2,019; 2,308; 1,674; 1,354; 1,866; 2,082; 1,608 Av: 1,78	n/a	6,755; 7,245; 6,745; 6,497; 7,031; 6,328; 7,103; 7,13; 7,129; 7,035 Av: 6,8998	0,07; 0,06; 0,064; 0,044; 0,069; 0,07; 0,043; 0,068; 0,082, 0,07 Av: 0,064
number of pulses	29; 27; 32; 38; 43; 29; 25; 34; 37; 28 Av: 32	n/a	168; 178; 172; 164; 169; 153; 178; 170; 175; 171 Av. 169,8	4, 4, 4, 3, 4, 4, 3, 4, 5, 4 Av: 4

pulse frequency[25], Hz	19; 19; 18; 19; 19; 19; 19; 19; 19; 19 Av: 19	n/a	21 and 29[26]; 20 and 29; 20 and 30; 20 and 29; 19 and 29; 20 and 29; 20 and 30; 20 and 30; 20 and 30; 20 and 29 Av: 20 and 29	57, 67, 63, 68, 58, 57, 70, 59, 61, 57 Av. 62
dominant fundamental frequencies, Hz	ca. 200-1300 (always the same)	ca. 200-1300 (always the same)	ca. 200-1300 (always the same)	ca. 200-1300 (always the same)

Table 1. Parameters of the different echemes in the call of *Oiophysa cumberi.*

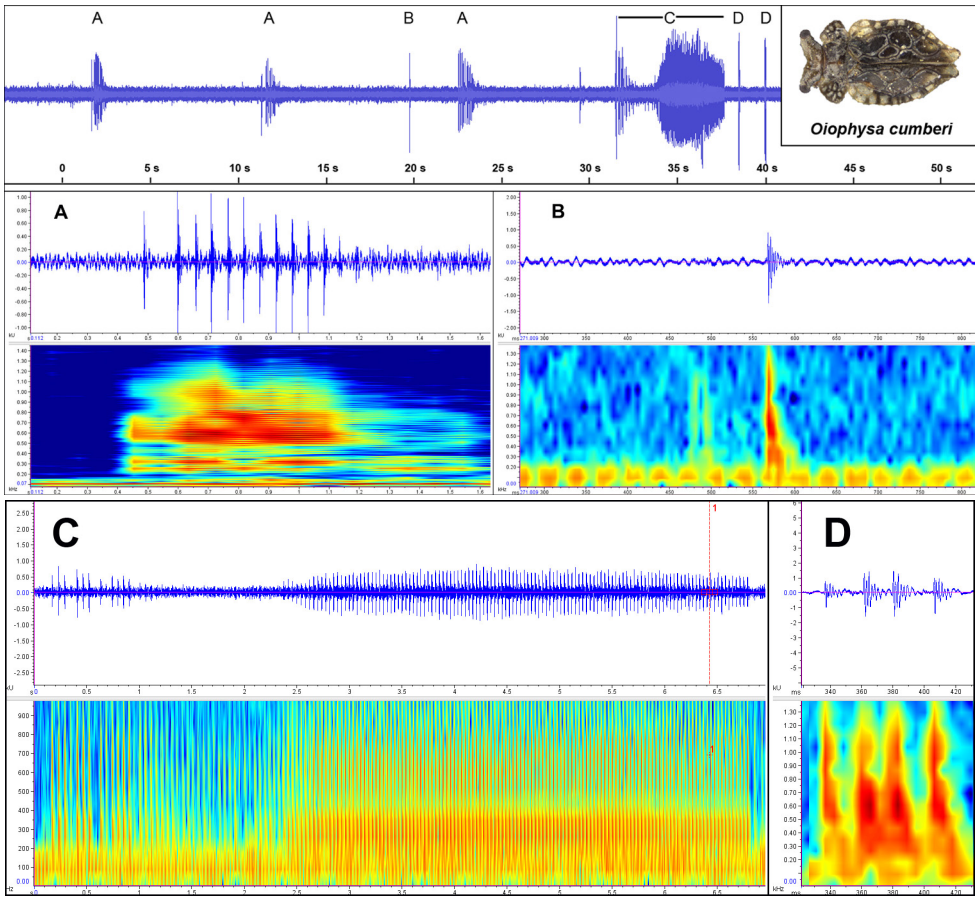

Figure 13. The call of *Oiophysa cumberi*. Above: oscillogram of the general structure of the call, with echeme types marked. A-D: the structure of the respective echeme types, with oscillogram (above) and spectrogram (below). Warmer colours in the spectrogram indicate higher amplitude, i.e. energy in the respective frequency range, colder colours indicate lower energy.

[25] Since the train of pulses sometimes missed a pulse or two, the frequency was estimated based only on the largest portion of the pulse trains without a lacuna; therefore, it is not quite equal to the total number of pulses/total echeme length relation.

[26] In echeme C, the frequency of the first part (the one that is very similar to type A) is distinctly lower than that of the last part, that is why the two were measured independently; a coherent train of pulses was selected in the end and in the beginning of the echeme that was used for that purpose (not all pulses of the echeme, since there is no sharp border between the slower first and the faster final part of the echeme).

The two specimens of *O. cumberi* could never be observed while producing vibrational signals and nothing can be said on their behavior while calling.

Xenophyes cascus

The call of this New Zealand species possesses two types of echemes (fig. 14; table 2.). The long one is a sequence of several hundreds pulses with a total length of 34-105 s. and pulse frequency of 38 Hz. Within the echeme, there are short pauses visible in spectrograms and oscillograms (fig. 14A). The long echeme starts very quietly, getting gradually louder and louder and ending abruptly. The short echeme is similar to the type D of *O. cumberi*: 2-3 pulses with average frequency of ca. 51 Hz.

Fundamental frequency: most energy is concentrated at 80 Hz and then in harmonics between 120 and 600 Hz, although as the call progresses and becomes louder, it attains values of 1100 Hz and (closer to the end) even 1700 Hz (fig. 14).

	echeme type A	**echeme type B**
duration, sec	86; 105; 94; 80; 93; 34; 63; 81; 72; 95 Av: 80	0,07; 0,07; 0,06; 0,06; 0,06; 0,06; 0,05; 0,06; 0,05; 0,06 Av: 0,06
number of pulses	n/a	3[27]
pulse frequency[28], Hz	41; 41; 41; 42; 40; 39; 41; 42, 42; 41 Av: 41	44; 43; 50; 50; 50; 50; 60; 50; 60; 50 Av: 51
dominant fundamental frequencies, Hz	ca. 80-750 (always the same)	ca. 80-750 (always the same)

Table 2. Parameters of the different echemes in the call of *Xenophyes cascus.*

[27] Only echemes with three pulses were analyzed here, although the species sometimes produces echemes of the B type with only two pulses. However, two pulses can indicate just a single movement of the tymbal musculature (that causes a bulging in of the tymbal when strained and bulging out when relaxed) and thus do not necessarily reflect the frequency of their contraction.

[28] Since the train of pulses sometimes missed a pulse or two (s. e.g. fig. 14, where there is a lacuna after the first pulse), the frequency was determined based only on the largest portion of the pulse trains without a lacuna; therefore, it is not quite equal to the total number of pulses/total echeme length relation.

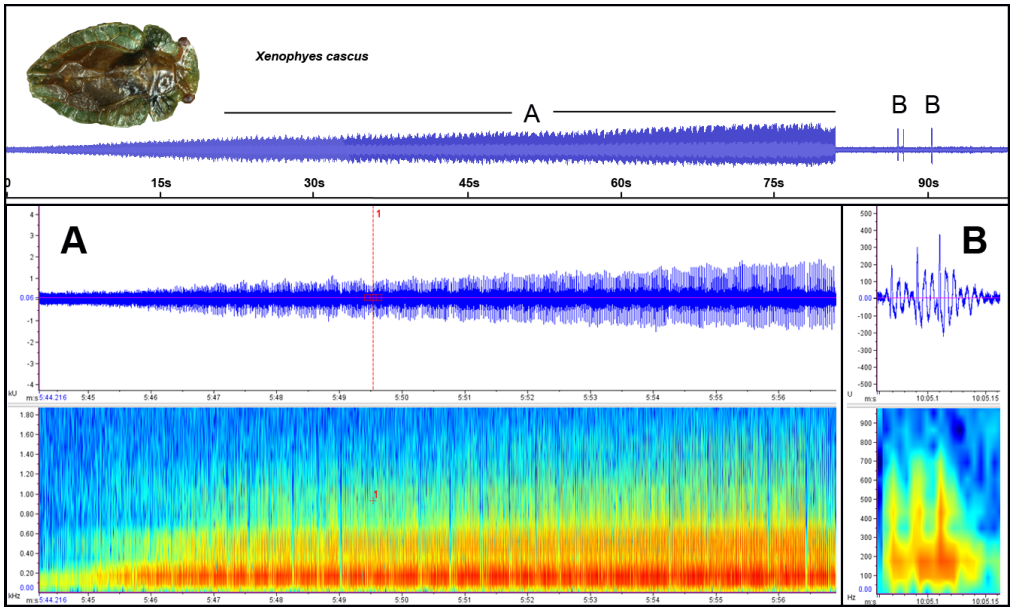

Figure 14. The call of *Xenophyes cascus*. Above: oscillogram of the general structure of the call, with echeme types marked. A-B: the structure of the respective echeme types, with oscillogram (above) and spectrogram (below).

Calling specimens of *Xenophyes cascus* were never seen moving while producing calls. In general, their calls could easily stop if the vial with the specimens was touched or even by approaching human steps.

Peloridium hammoniorum

The call of this South American species is a sequence of very loud monotonous single or double pulses with frequency of ca. 0,6 Hz (fig. 15; table 3). The sequence can go on without alteration for 40 minutes, until at some point the pulse frequency rises abruptly to some 3-4 Hz; this period oh higher frequency can last for some seconds. After that the animal can become silent or return to the normal pulse frequency.

The fundamental frequency of the call occupies a wide region between 0 and 2400 Hz, but the parts where most energy is concentrated are between 50-200 Hz and 350-600 Hz (fig. 15).

Pulse frequency, Hz, (normal)	**Pulse frequency, Hz, (climax)**
0,7; 0,6; 0,6; 0,6; 0,5; 0,5; 0,5; 0,7; 0,7; 0,7 Av: 0,6	3; 3; 4, 4, 4; 3; 4; 4, 4; 2 Av: 4

Table 3. Pulse frequencies of the "normal" call and the "climax" in *P. hammoniorum.*

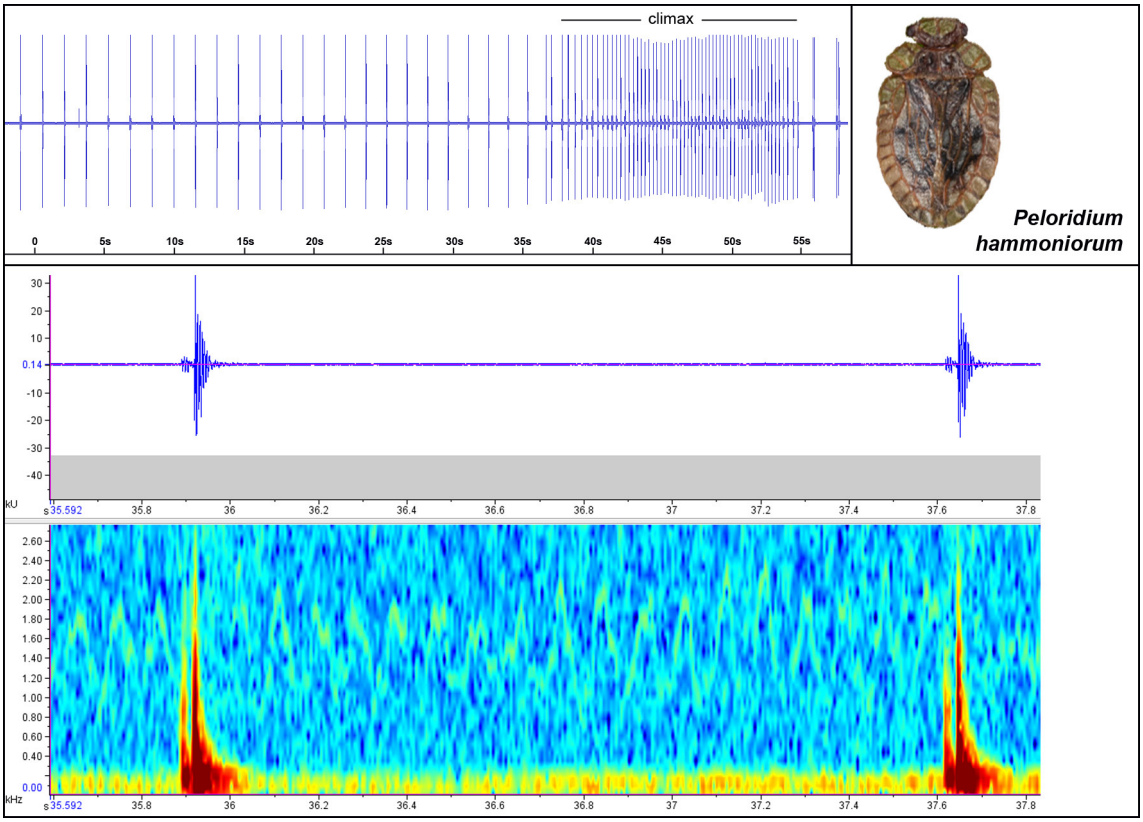

Figure 15. The call of *Peloridium hammoniorum*. Upper part: oscillogram of the general structure of the call, lower part: details of the pulse structure, with oscillogram (above) and spectrogram (below).

Production of vibrational calls in specimens of *P. hammoniorum* was caused by the dorsoventral tremulation of the abdomen (described in the Results section 3.1.). Calling specimens could be very mobile (by peloridiid measure), walk and ride females, other males or larvae. Three specimens (two males and one female) were observed with the female below, one male on its back and the second male on the back of the first, the uppermost male vibrating his abdomen most actively, the lower male somewhat less.

Peloridium pomponorum

The call of this South American species was very similar to its congeneric: also a sequence of monotonous single or double pulses with frequency of ca. 0,4 Hz (fig. 16; table 4). The sequence could go on without alteration for a while, fade away or at some point the pulse frequency could rise abruptly to some 2-3 Hz; this period oh higher frequency could last for some seconds and could sometimes be repeated. After that the animal could become silent or return to the normal pulse frequency.

The fundamental frequency of the call occupied the range between 0 and 800-1000 Hz (fig. 16).

Production of the signals, as in *P. hammoniorum*, was caused by the abdominal tremulation in this species. Specimens of *P. pomponorum* were as mobile as their congenerics, with walking and riding during the calling as common as in the other species.

Pulse frequency, Hz, (normal)	Pulse frequency, Hz, (climax)
0,4; 0,4; 0,3; 0,4; 0,4; 0,4; 0,4; 0,4; 0,4; 0,4 Av: 0,4	2; 1,25 Av: 2

Table 4. Pulse frequencies of the "normal" call and the "climax" in *P. pomponorum.*

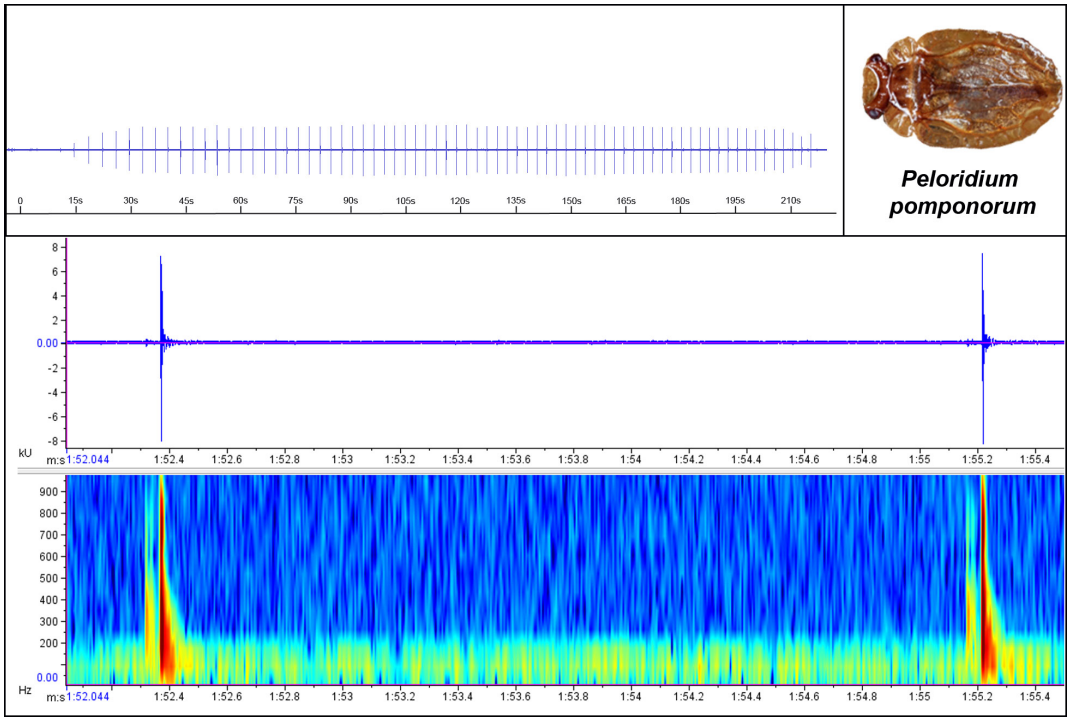

Figure 16. The call of *Peloridium pomponorum*. Upper part: oscillogram of the general structure of the call, lower part: details of the pulse structure, with oscillogram (above) and spectrogram (below).

Hackeriella veitchi

The record of this Australian species was produced by Hoch et al. (2006) and is characterized here based on their recording (fig. 17). It is a brief sequence of several seconds' duration. The call consists of short pulse trains (9-10 pulses each) with the pulse frequency of 7-8 Hz. The fundamental frequencies are between 80 and 160 Hz, although traces of some more energetic pulses are seen at 180-220 Hz, too.

The species was never observed while producing vibrational signals.

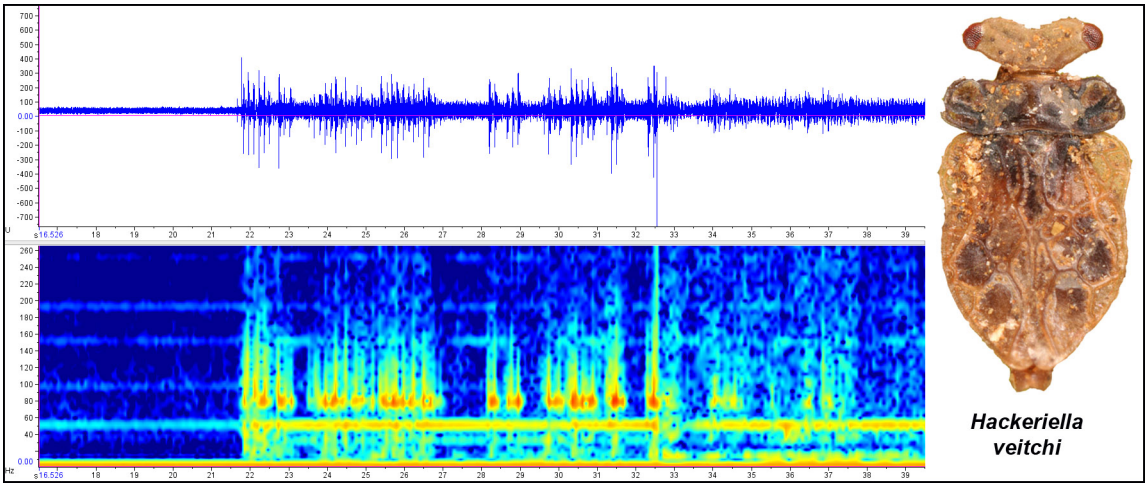

Figure 17. Call of *Hackeriella veitchi*. Above: oscillogram, below: spectrogram.

4 Discussion

4.1 Host plants of Peloridiidae

The host plant preferences were inferred indirectly in this study, since in many cases (due e.g. to field conditions) direct observations of Peloridiidae actually feeding on the bryophyte species they were collected upon were not possible. However, in cases when such observations were made (e.g. *Hackeriella brachycephala* on native *Dicranoloma* species; *Hackeriella veitchi* on *Brachythecium rutabulum* from Germany; *Peloridium* on native *Sphagnum* and *Polytrichadelphus magellanus* and a *Polytrychum* sp. from Germany; *Xenophyes cascus* on native *Wijkia extenuata, Ptychomnion aciculare, Hymenophyton* sp., *Plagiochila* sp. and *Bryum bicolor* from Germany; *Oiophysa cumberi* on *B. bicolor* from Germany; *Pantinia darwini* on native *Arbusculohypopterygium arbuscula*), the insects actually fed on the respective species. Taking into consideration that different Peloridiidae species would feed even on German bryophytes that are probably not familiar to them in the native habitats (e.g. *X. cascus* feeding on *B. bicolor*), it is highly likely that they really feed on all the bryophyte species they were found upon. This fits well with their low taxonomic specificity in the choice of the host plants.

Some of the literature records on host plants affinities of Peloridiidae could be tested during the present study. All species reported from *Sphagnum* (s. table 5.) were also repeatedly found on different species of this genus – *H. crassus, H. leai, P. pomponorum*. *Porella elegantula*, although recorded as a host species for *Howeria*, the moss bug from Lord Howe Island (Evans, 1967), was found to host the New Zealand *X. rhachilophus* and is thus proven suitable as a host plant. *P. hammoniorum* was found to occur on *Polytrichadelphus magellanicus*, as described by Shcherbakov (2014). *Pohlia cruda*, a species reported by China (1962) and Cekalovic (1986) to harbour the Australian *P. hammoniorum*, was sampled in Australia (in NSW, Kosciuszko NP, Charlote's Pass) – but did not deliver any Peloridiidae, as the locality as the whole (and is therefore not included in the detailed field data set in the Supplement 1.).

Some of the literature records, however, can be considered doubtful on the basis of the present study. For instance, Helmsing & China (1937) reported *Hackeriella veitchi* from the pendant epiphyte moss species *Papillaria crocea*. It was tested several times on different localities in Australia (including those from Lamington National Park, from where Helmsing & China, 1937, reported the host plant) and only once delivered a single peloridiid specimen (although not *H. veitchi*, but closely related *Hackeriella brachycephala*). The sample also contained admixtures of other bryophyte species, and it is very likely that it were those that delivered the peloridiid specimen. Hanging epiphytes of the pendant life form (Mägdefrau, 1982) were found to be avoided by peloridiids in all regions – those never occurred e.g. on species of the genus *Weymouthia* or on hanging lifeform of the moss *Wijkia extenuata* (although the mat lifeform of this species repeatedly delivered specimens of Peloridiidae in Australia and New Zealand). The key to this contradiction might be the fact that Helsming and China (1937) described how "a dead, water-soaked moss-covered twig of the beech was […] picked up" and *Hackeriella veitchi* found on it, indicating that the moss specimen was not

hanging, but lying on the ground. In this case it is just an illustration of the typical behavior of Peloridiidae that seem to stick to whatever bryophyte species offers them a stable moist environment, which a hanging epiphyte is not capable of, but the same species lying on the wet forest floor very well is.

The statement of Evans (1982) who wrote that Peloridiidae "are largely confined to particular mosses even in environments where an abundance of species of these plants occur" is not supported unequivocally by the results of this study, since some moss bugs do occur on a very wide range of host plants (e.g. the genus *Xenophyes*), whereas others are more selective and some do seem to be confied to particular bryophytes. Another statement by Evans (1982) that the "principal factor most favouring peloridiid populations is the occurrence of suitable mosses situated in permanently wet environments" does seem true, but demands further study under consideration of climatic, botanical and other factors (Hartung, Kürschner & Brown, in preparation).

Peloridiid species	**Bryophyte species**	**Region**	**Reference**
Hackeriella veitchi	*Papillaria crocea* (Hampe) A. JAEGER (as *P. kermadecensis* (MÜLL. HALL.) A. JAEGER[1])	Australia	Helmsing & China, 1937
Hemiodoecus crassus	*Sphagnum* sp.	Australia	Burckhardt, 2009
Hemiodeocus leai	*Sphagnum* sp.	Australia	Burckhardt, 2009
Howeria kingsmilli (as *H. coggeri*)	*Spiridens vieillardii* SCHIMP.	Lord Howe Island	Evans, 1967
Howeria kingsmilli (as *H. kingsmilli, H. paytenii*)	*Porella elegantula* (MONT.) E.A. HODGS (as *Madotheca stangeri* LINDENB. & GOTTSCHE in GOTTSCHE, LINDENBERG & NEES[2])	Lord Howe Island	Evans, 1967
Xenophyes sp.	*Notoligotrichum crispulum* (HOOK.f. & WILSON) G.L.SM. (as *Psilopilum crispulum* (HOOK.f. & WILSON) MITT.[3]	New Zealand	Carter, 1950
Oiophysa distincta	*Weymouthia* sp. (?)	New Zealand	Burckhardt, 2009
Peloridium hammoniorum	*Pohlia cruda* (HEDW.) LINDB.	South America	China, 1962; Cekalovic, 1986
Peloridium hammoniorum	*Polytrichum strictum* MENZ. ex BRID.	South America	Estévez & de Remes Lenicov, 1989
Peloridium hammoniorum	*Polytrichum strictum* MENZ. ex BRID.	South America	Burckhardt, 2009
Peloridium hammoniorum	*Polytrichadelphus magellanicus* (HEDW.) MITT	South America	Shcherbakov, 2014
Peloridium pomponorum	*Sphagnum magellanicum* BRID., *Sphagnum* cf. *recurvum* P. BEAUV.	South America	Shcherbakov, 2014

Table 5. Literature records on host plants in Peloridiidae.

[1]Synonymized in Streimann (2012)
[2]Synonymized in So (2002)
[3]Synomymized in Hyvönen (2012)

Since Peloridiidae in every biogeographic region studied occurred on representatives of the families Dicranaceae, Hypopterygiaceae, Polytrichaceae and Sphagnaceae, it is worth recommending in a new locality to start collecting Peloridiidae on bryophytes of those 4 families.

A striking feature of Peloridiidae as family is the quite low specificity in choice of host plants. Herbivore insects are often specialists (Rausher, 2001), since this strategy makes it easier to cope with the plant defense systems such as secondary metabolites (Fraenkel, 1959). Bryophytes are very famous for being not palatable (Gerson, 1982; Frahm, 2001) and for the richness of their secondary metabolite spectrum (Xie & Lou, 2009; Haines & Renwick, 2009), so that only few organisms normally feed on bryophytes and even less are bryophyles specialized to feeding on them (Gerson, 1982).

Under these prerequisites, a high degree of taxonomic specialization in Peloridiidae could be expected, but the results of the present study demonstrate that it is not so, although some genera were found to be more specific than others or even prefer some particular bryophyte species. On the other hand, a low specificity in *Xenophyes* seems to be a unique trait within the family and a characteristic feature of the genus.

How exactly Peloridiidae cope with the secondary metabolites that bryophytes are so rich on, is not known yet. The role of their bacterial symbionts is most likely neglectable – these do not possess any gene complexes that would allow them to detox the secondary compounds ingested with the food (Santos-Garcia et al., 2014). The bacterial symbionts cannot take part in the detox process for other reasons, too: they are kept in specialized organs, the bacteriomes, where the contact with the gut contents is almost impossible. The detoxification of the secondary metabolites most likely happens in the Malpighian tubules (Stefan Küchler, personal communication); a role of the salivary glands and/or midgut glands as in *Issus coleoptratus* (Himmelsbach et al., 2016) is conceivable, too. It is also possible that the sucking mouthparts enable the Peloridiidae to avoid contact to many secondary metabolites that are located in the cell wall; this hypothesis is supported by the fact that many bryophylous organisms also posses sucking mouthparts, like other Hemiptera or Tardigrada. However, even in this case it is not clear how Peloridiidae cope with the secondary substances from oil bodies that are typical for liverworts (Frahm, 2001) and are not located in the cell wall, but enclosed by membranes.

The host plant preferences of Peloridiidae seem to be governed by a complex interaction of various factors – climatic parameters of a particular locality (precipitation, temperature), bryophyte morphology (e.g. life-form, conductive tissue) and bryophyte taxonomy, the last one being not the most important. However, climatic features and morphological traits of host bryophytes are beyond the scope of the present study and are treated by Hartung, Kürschner & Brown (in preparation).

An interesting argument *pro* the role of bryophytes for Peloridiidae as providers of the necessary ecological conditions is given by the numbers of individuals that were collected (s. Supplement 1.). In most cases, the numbers of the collected specimens were quite small – except for regions with high precipitation rate such as Tasmania or Fiordland NP (New Zealand). In locations with less precipitation high individual numbers of Peloridiidae were observed on the bryophyte species that are able to build an extensive and tight turf that is most effective in saving the moisture – *Polytrichadelphus magellanus* in Chile or *Sphagnum* species in all three regions analyzed during the present study.

An interesting feature is the common sympatry, even syntopy of Peloridiidae. On several occasions different species were collected on the same location from the same host plant: *H. veitchi* and *H. echina*, *H. acutus* and *H. wilsoni*, *H. fidelis* and *H. leai*, *P. darwini* and *P. holdgatei*, *X. rhachilophus* and *X. greensladeae*, *X. rhachilophus* and *O. distincta*, *X. cascus* and *O. cumberi* (s. Supplement 1.). The only case where this co-occurrence on the same host plants was an exception is demonstrated by the two *Peloridium* species. Among the diagnostic characters given by Shcherbakov (2014) for the species are their different host plants (*Polytrichadelphus magellanus* for *Peloridium hammoniorum* and *Sphagnum* species for *Peloridium pomponorum*). Indeed, only once a specimen identified by characters from Shcherbakov (2014) as *Peloridium pomponorum* was found on *P. magellanus,* and

only one specimen of *Peloridium hammoniorum* on *Sphagnum falcatulum*. This is rarer than could be expected, since *P. magellanus* and *Sphagnum* were often growing side by side in the locations where both *Peloridium* species were collected, and specimens of both *Peloridium* species would sit on each other's host plants in the lab (although not observed feeding). Another character separating the two *Peloridium* species is the fulvous colour (and generally lighter facies) of *P. pomponorum* when compared to *P. hammoniorum* that is "rusty brown". This might be a dietary artefact: *H. leai* from Kosciuszko NP in Australia and *X. kinlochensis* from Fiordland NP in New Zealand both were found in *Sphagnum*, and at least for *H. leai* specimens from *Sphagnum* were also much lighter in colour than their conspecifics occurring on other bryophytes. *Hemiodoecus crassus*, that was only collected on *Sphagnum*, also had very similar fulvous colour. Consulting morphological results, the only difference between specimens of the two *Peloridium* species in the character matrix (Results, section 3.4.) are the integumental glands on abdominal terga being in *P. hammoniorum* different in structure from those elsewhere on the body, whereas in *P. pomponorum* such anomalous glands on abdominal terga seemed to be rarer. However, it must be said that only one specimen of *P. hammoniorum* and two of *P. pomponorum* were analyzed in regard to this character (Supplement 4) and in *P. pomponorum* glands that were different in structure were found too. Thus, the results of the present study might cast doubt on the vailidity of the newly described *P. pomponorum* (Shcherbakov, 2014).

Another species that demonstrates some disparity in relation to host plant affinities is *Hemiodoecus leai* from Australia. In alpine zone of Kosciuszko NP it is confined to *Sphagnum*; in Yarra Ranges NP it was very selective and rare, whereas in Tasmania *H. leai* occurred on most bryophyte species that were analyzed. However, these differences might also be explained by different levels of precipitation or temperature in different regions and habitats of the species.

4.2 Characters pertaining to fine morphology

4.2.1 Peloridiidae

4.2.1.1 Characters of the head

Antennae

The small flagellum in Peloridiidae bears basically only three types of sensilla: several smooth socketed trichoid sensilla (most likely mechanoreceptors), a large placoid sensillum on the tip (olfactory function seems the only reasonable function here) and several coeloconic sensilla that are grouped in its proximity. China (1962) already illustrated the placoid sensillum (China, 1962; figs. 3g, 8f, 10g, 11 g-h), although did not discuss the structure in the text; still, he calls it in the legend to his fig. 11h a "sensory structure on the antenna". Bourgoin (1985) briefly examined the antennal tip of *Hemiodeocus leai* and determined that it bears a placoid sensillum, but did not study it further. Estévez & de Remes Lenicov (1989) provided a photograph of the antennal pit of *Peloridium hammoniorum* and briefly mentioned a prolonged stretch of thin cuticula (= the placoid sensillum)

and a row of pits on the flagellomere and recognized those as sensillar structures, but a detailed study of the structures was beyond the scope of their bionomical paper. The coeloconic sensilla were also noticed (although not further discussed) by Spangenberg et al. (2013) and referred to as “pits”.

The details of the coeloconic sensilla’ fine structure that can be seen e.g. in *Oiophysa ablusa* (plate fig. 3) resemble the ridged peg within the coeloconic sensillum in Auchenorrhyncha: Cercopidae studied by Liang & Fletcher (2002, fig. 4a). Thus, the coeloconic sensilla of Peloridiidae might be olfactory chemoreceptors, analogous to coeloconic sensilla with ridged pegs in Cercopidae (Liang & Fletcher, 2002) or Aphrophoridae (Ranieri et al., 2016). However, the role as thermo- and hygroreceptors cannot be ruled out, since coeloconic sensilla often can fulfil this function, too (Altnher & Prillinger, 1980). If one considers preponderance of Peloridiidae for humid environments, a high number of hygrosensitive coeloconic sensilla on the antennae would appear plausible. Thermo- and hygroreceptors are normally rare compared to other sensilla types (Altner & Prillinger, 1980), whereas a group that so eagerly avoids desiccation and pursues humidity as Peloridiidae must have more of them. However, the thermo- and hygroreceptive or olfactory role can only be stated with certainty after ultrastructural studies on peloridiid antennae are performed.

The similarity in fine structure of coeloconic sensilla is not the only one between Peloridiidae and Cercopoidea. The Aphrophoridae genus *Anyllis* from Australia (Liang et al., 2005) has a sensillar configuration on the flagellum that strongly reminds of Peloridiidae – if e.g. the flagellum (figs. 3-5 in Liang et al, 2005) did not have an arista, it would be in form and arrangement perfectly similar to a peloridiid antenna. The placoid and coeloconic sensilla in Peloridiidae seem to build some functional entity or be governed by some common constructional principles, since a change in the architecture of the placoid sensillum in genus *Peloridium* goes along with a change in the order of the coeloconic sensilla. Similar development seem to exist in Aphrophoridae and Cercopidae, where the flagellum base is occupied by a number of coeloconic sensilla and 1-3 placoid (or multiporous basiconic) sensilla. It is unlikely that such similarities can be used as arguments for closer relatedness between Peloridiidae and Cercopoidea, but the fact is worth mentioning. It may be a parallel development on the basis of common genetic background of Hemiptera. In this regard Bourgoin’s notice (1985) is worth mentioning, where he writes of similarities between the flagellum tip in Peloridiidae and the bulbous flagellar base in young larvae of Tettigometridae (Auchenorrhyncha: Fulgoromorpha) and suggested that they could be homologous.

Burckhardt (2009) uses the number of the antennal segments to discern the 5th instars (2 segments) from younger larvae (1 segment) in his larval key. Data of the present study do not fully support this view. Whereas the development of the antennae in *H. brachycephala* seems to fit with Burckhardt’s model, in the 5th instars of *Xenophyes cascus* (plate fig. 8a) and *X. rhachilophus* (plate fig. 7) the border between the scape and pedicel, although clearly indicated as a constriction, still is not a complete intersegmental border, the antenna being single-segmented. The antennae of younger (1-2 instars) larvae of *Peloridium* do not quite fit Burckhardt's key, too, since the border between the base of the scape and the body wall is not recognizable (plate fig. 8b) and the antenna is thus non-segmental. A study of larvae of further peloridiid species might uncover more variation in development of antennae that could lead to a revision of the key to larval instars provided by Burckhardt (2009).

Genal area under antenna

The genal area in Peloridiidae has a unique condition among Hemiptera due to the singular structure of the head; thus a reasonable comparison of this trait between Peloridiidae and other hemipterans was impossible and its features were only used for the intrafamiliar systematics.

One trait – or better, its absence – that needs to be mentioned is Evans' organ that was found by Bourgoin (1986) in *Hemiodoecus leai* and used for hypotheses on Hemiptera phylogenetics. Later, Spangenberg et al. (2013) did not observe it in *Hackeriella veitchi*. Hartung & Bourgoin (in preparation) demonstrate that Evans' organ does not occur in Peloridiidae.

Labium tip

The last segment of the labium and the sensilla on its tip in the Peloridiidae has already been described elsewhere (Brożek, 2007; Spangenberg et al., 2013). Still, the sampling of our study is much bigger than in those works, which allowed us to test for the generality of the sensillar pattern and also discover some new traits that can be used for phylogenetic analysis of the family. For instance, the coeloconic sensillum has not been mentioned by the previous authors and neither was the different configuration of the inner circle of trichoid sensilla (laterally or antisuturally of the stylet orifice). As for the pattern of 4 pairs of trichoid sensilla in the outer circle, 2 pairs in the inner + 1 coeloconic sensillum located in the outer circle between the 3. and the 4. seta, it was found to be typical for all studied representatives of the family.

Brożek's (2007) observation of the trichoid sensilla having a surface "divided by shallow grooves and tiny pores" is not inambigously supported by our data. Brożek (2007) does not specify which sensilla have porose/grooved surface; in our SEM pictures the outer sensilla appear smooth (plate fig. 34B), but the inner sensilla might have large pores (plate fig. 34C). However, even a smooth surface might carry fine pores that are only visible in transmission electron microscopy. So, olfactory function of the trichoid sensilla is not supported by our data, but cannot be completely ruled out either. Their mechanical function is likely, since the sockets are moveable. On the other hand, the coeloconic sensillum carries visible pores and is clearly chemosensitive. Still, the exact modality is not clear in its case, too: in some species only multiple fine pores are visible that suggest olfactory function (plate fig. 37A), in other species even within the same genus the pore might be single and large (plate fig. 37B) indicating gustatory role, whereas in yet others both large terminal pore and fine wall pores are visible (plate fig. 37C), suggesting some kind of dual olfactory-gustatory role. The last word must be said here by TEM, for now it is just worth mentioning that sensilla with both terminal pore and multiple fine pores are also known from the true bug family Pyrrhocoridae (Schoonhoven & Henstra, 1971; Peregrine, 1972; Gaffal, 1981).

The configuration of the inner sensilla seem to always enable a contact with the broader side of the stylet bundle, whether the mandibles are oriented laterally (plate fig. 36A) or twisted at 90° (plate fig. 36B). It is likely that their role is to provide the animal with information on the stylets'

attachment to each other and/or on the substances leaking through crevices of the alimentary canal that are facing in this direction.

4.2.1.2 Characters of the thorax

Surface sculpture of tegmina

The sculpture on the ventral surface of the tegmina in Peloridiidae is diverse as in no other hemipteran taxon, but its role is elusive. The surface is definitely water-repellent, as was shown by Hartung et al. (2016), and might be helpful in retaining an air bubble under the tegmina *in situ*. The sculptured part of the ventral surfaces is the part that is in contact with the plastron structures on the dorsal abdomen, which makes an air-retaining function plausible; the parts that stick out laterally (C, costal cells, ScA) are structured differently and their role is most likely different. Whether air-retaining is the only possible function of the sculpture must remain a question to be solved by future research.

The bare spot on the apical radial cell in the genera *Hackeriella*, *Hemiodoecus* and *Hemiowoodwardia* implies that some specialized organ or cuticular spot might be present on the apically on the dorsal abdomen that is covered by this part of the tegmen, although nothing was found as yet. Anatomical investigation in the mentioned species could be of interest.

Distal hind leg

Szwedo et al. (2011) described *Ilahulgabalus endaidus*, the only amber fossil of a Coleorrhyncha known up to date, that allows access to some finer morphological features, i. a. morphological details of the hind legs. The authors place this species into Cicadocorinae, a family that is considered by some paleontologists (e.g. Popov & Shcherbakov, 1996) to be a stem-group representative of the Coleorrhyncha. However, when one compares the hind tibia and tarsus of *I. endaidus* and modern Peloridiidae, many differences become obvious. The tibial spurs are 5 in number in *I. endaidus*, whereas Peloridiidae have 4 at most; the spurs seem to be moveable in *I. endaidus*, but in Peloridiidae these are always immobile acantha-like. There are 3 tarsal segments in *I. endaidus* against 2 in all Peloridiidae species. Finally, arolium in *I. endaidus* is clearly a bilobed one, whereas in Peloridiidae it is simple. These characters do not put *I. endaidus* in phylogenetic proximity of Peloridiidae, but rather imply relatedness to Cicadellidae. In our analysis, *C. viridis* has a bilobed arolium and moveable thick setae on distal hind tibiae (plate fig. 80); the bilobed arolium was also found in the membracid *Centrotus cornutus* (Friedemann & Beutel, 2014) and might be a synapomorphy of Membracoidea. Thus, tibial and tarsal characters are more likely to support relations of *I. endaidus* to Membracoidea than to Peloridiidae.

4.2.1.3 Characters of the abdomen

Water-repellent structures and dorsal abdomen

Hartung et al. (2016) describe that the wax-covered microtrichia of the dorsal abdomen in Peloridiidae are water-repellent and able to hold a bubble or a layer of air, at least for a while, and thus can be considered structural plastron. Structural details of the plastron in different species provide useful characters for phylogenetic analysis. When microtrichia are grouped or occur in assemblages of several pieces at a time, this probably indicates their common origin from a single cell. Strictly speaking, the sculptural elements might not always be microtrichia (i.e., several elements all originating form one cell, Richards & Richards, 1979), as e.g. in *Idophysa chonos* who has particularly large elements. In this species it is likely that one cell only produces a single cuticular protuberance (i.e., these are acanthae, Richards & Richards, 1979). However, until this has been demonstrated, this difference is not considered and sculptural elements in all species are referred to as microtrichia.

4.2.1.4 Characters of the general body surface

Integumental glands

The structures in question are interpreted here as integumental glands and not as sensilla due to following argumentation. Since in all the structures some orifices are recognizable (e.g. plate fig. 31), these can only be chemosensory sensilla or glands. The pores in chemosensory sensilla (e.g. olfactory sensilla in the plate fig. 3. or gustatory sensilla in the plate fig. 56C) are very small, nanometer-scale and do not actually look like openings under scanning electron microscope, since the pores are completely covered during sputter-coating. The pores in the structures in question are hundreds of nanometers or even a micrometer wide; this does not corroborate the sensilla hypothesis. Next, chemosensilla are normally concentrated on some body parts that regularly come in contact with chemical cues of the environment: antenna, tarsi, labium tip or ovipositor. No case is known, where chemosensilla would be so common and so widespread on the body surface (i.a. on dorsal surface of the tegmina or on abdominal tergites where olfactory or gustatory sensilla are extremely unplausible) as the structures in question are. Then, the mysterious structures in Peloridiidae look extremely similar to the floral glands of *Dysdercus fasciatus* (Heteroptera: Pentatomomorpha: Pyrrhocoridae) that were demonstrated to be glands by Lawrence & Staddon (1975). Jia & Liang (2015) found integumental glands of similar morphology in an *Aquarius* (Heteroptera: Gerromorpha: Gerridae), whereas Fröhlich & Lu (2013) demonstrated the glandular nature for the “rosette-like structures” which diversity Matushkina (2010) documented for Zygentoma and Archaeognatha; the rosette-like structures are again quite similar to the structures of Peloridiidae. Investigations on *Corythucha ciliata*, *Issus coleoptratus* and *Aphrophora alni* confirmed that structures in question are really glands (Hartung, unpublished). Thus, although a definite evidence for Peloridiidae has not yet been presented, the structures are considered here integumental glands.

Larvae and adults of all analyzed species of Peloridiidae were covered in secretion that has already been mentioned by earlier authors (China, 1962; Burckhardt, 2009; Hartung et al., 2016); only the regions that are occupied by plastron were free of it. The secretion obscures all the finer surface structures and requires special procedures for removal (s. Hartung et al., 2016 and Materials and Methods for a more detailed discussion of the problem). The function of the secretion is yet completely unknown. No macroscopic gland that could be responsible for this secretion had been described for the taxon, but the significant numbers of microscopic integumental glands that were discovered in Peloridiidae during our study are possible candidates as production sites of the secretion. A remarkable parallel is the absence of the secretion on body regions that carry plastron and extreme rarity or absence of the integumental glands on the same regions.

The function of the peripheral elements surrounding the orifice of the glands is not clear, although it has been suggested (Lawrence & Staddon, 1975) that they play a role in dispensing of the secreted substances on the surface of the animal.

Although integumental glands in larvae of only 4 species were studied, they all differed in structure and can be used as taxonomic characters. Thus, integumental glands were distinctly different in closely related species of *Xenophyes* (fig. 37), which may even allow identification of younger larval instars, since in Peloridiidae only last instar larvae can only be identified to species at the moment (Burckhardt, 2009, Burckhardt et al., 2011), and even here with not very much certainty. This character is even more promising, if one considers that *X. cascus* and *X. rhachilophus* shown in plate fig. 37 are two most closely related species of the genus in the phylogenetic analysis (s. Results, section 3.5.).

4.2.1.5 Some previously reported characters

Friedemann et al. (2014) used Peloridiidae in their morphology-based phylogenetic analysis of Acercaria and found a sister-group relationship between moss bugs and Heteroptera, with such synapomorphies as absence of tegulae, presence of cephalic trichobothria, tubular labium with 4 segments and antennae with 4 or less segments. However, cephalic trichobothria have never been registered in any peloridiid species during the present study and antennae of Auchenorrhyncha quite often possess a single arista-formed flagellomere too (and thus less than 4 segments), which makes two characters of Friedemann et al. (2014) at least doubtful. Yoshizawa et al. (2017) demonstrated the presence of tegulae in at least one Peloridiidae species.

Hamilton (1981) in his study of hemipteran heads reported a gula that has since been cited as a synapomorphy of Heteroptera and Peloridiidae (e.g. Grimaldi & Engel, 2005) and was even used as an argument for including Peloridiidae within Heteroptera (Carver & Gross, 1991). However, a gula has not been found in any Peloridiidae species under the present study – a result corresponding well with data of Spangenberg et al. (2013). Another synapomorphy of Heteroptera and Peloridiidae, thoracic scent glands (used by Grimaldi & Engel, 2005, in the construction of a cladogram on p. 263), have never been found during this study, too. Thus, gula and thoracic scent glands seem to be absent from Peloridiidae and should better not be used as synapomorphies for Heteropterodea.

4.2.2 Outgroups

4.2.2.1 Characters of the head

Antennae

Sternorrhyncha. The apical setae on the terminal flagellomere of *Psylla alni* (plate fig. 39B) that have both multiporous walls and a large terminal pore are clearly chemoreceptors, probably with combined olfactory and gustatory function. Onagbola et al. (2008), who studied antennal sensilla of another Psyllidae, *Diaphorina citri*, found very similar structure of the apical setae and consider them as having both chemo- and mechanosensitive function. The socketed grooved trichoid sensilla of *P. alni* (plate fig. 38B) most likely correspond to the aporous sensilla trichodea (AST) found by Onagbola et al. (2008) and like in their study constitute the most numerous type of antennal sensilla, found on every antennomere. As for the multiporous olfactory sensilla, only one (not counting the apical setae) was found on the 7th flagellomere in *P. alni* (plate fig. 39C), whereas Onagbola et al. (2008) discovered 5 more on different segments of the flagellum (MST of the authors). Here, two explanations are plausible – either *Psylla alni* actually has less sensilla of this type than *D. citri*, or they could not be recognized on their external appearance only. Transmission electron microscopical studies would be necessary to clarify this issue. As for the coeloconic sensilla, Onagbola et al. (2008) found 4 (on the flagellomeres 2, 4, 6 and 7), Moran & Brown (1973) 5 in *Trioza erytreae* (flagellomeres 2, 4, 6, 7, 8), Kristoffersen et al. (2006) 5 in T*rioza apicalis* (flagellomeres 2, 4, 6, 7, 8), whereas in *P. alni* only 3 (flagellomeres 4, 6 and 7) were discovered (plate figs. 38B and 39D). A similarity between P*. alni* and *T. apicalis* studied by Kristoffersen et al. (2006) is that the only coeloconic sensillum that showed a structure that was visible from outside was the one on the 7th flagellomere. However, Kristoffersen et al. (2006) discovered that every cavity on the antenna of *T. apicalis* hosted two sensilla, so it is possible that the structures named coeloconic sensilla in *P. alni* are in truth complex associations of two or even more sensilla. A descriptive term that is often used in Sternorrhyncha (e.g. Ossiannilsson, 1992) is “rhinarium”, although this is not a perfect one, since there are primary and secondary rhinaria that denote quite different organs in aphids. Primary rhinaria (or sensoria) of aphids are complex structures that may include true coeloconic sensilla (Bromley et al., 1979; Sun et al., 2012), whereas secondary rhinaria are non-homologous placoid sensilla (Bromley et al., 1979). As for the function of the coeloconic sensilla/rhinaria, nothing can be said with certainty about *P.alni*; Kristoffersen et al. (2006) provide evidence that at least one of the two sensilla that are located in cavities are olfactory, whereas the structure of the other does not allow any safe conclusions, although Kristoffersen et al. (2006) and some other authors after them speculate on a role as thermo- and hygroreceptors. Bromley et al. (1979) demonstrated structural similarity of coeloconic sensilla in aphids to those of mosquitoes, for which a function as thermo- and hygroreceptors had been demonstrated. Thus, the coeloconic sensilla of *P. alni* might be complex olfactory/thermo- and hygroreceptive organs, although this is not certain until ultrastructural investigations are made.

Coeloconic sensilla in *P. alni* are concentrated on the lateral surface of the flagellum. It is not unusual for this sensillum type to be concentrated on particular regions of the antennae, for instance, ventrally in Aleyrodidae species (Mellor & Andersen, 1995), or lateroventrally in a *Libellula* (Rebora et

al., 2008). In the Peloridiidae species of the present study, the coeloconic sensilla are also found only on the dorsoposterior surface of the flagellum.

Cicadomorpha. The antennal architecture and sensillar configuration of *C. sanguinolenta* is similar to those described for Cercopidae species from different tribes and biogeographical regions: *Opistharostethus* (Liang & Jiang, 2001), *Prosapia* (Liang, 2001b), *Baibarana* & *Telogmometopius* (Liang et al., 2006), several representatives of Rhinaulacini (Liang & Webb, 2002) and some not explicitly discussed data on the Neotropical family Ischnorhininae (Paladini et al., 2015) and thus can be considered typical for the family (although number and form of specific sensilla types do vary within it). Basiconic sensilla on the scape and long socketed trichoid sensilla on pedicel seem to have pure mechanosensitive function. Basiconic sensilla on flagellum of *Cercopis sanguinolenta* with their multiporose surface suggest an olfactory function. As for coeloconic sensilla of Cercopidae, Liang (2001b) and Liang & Fletcher (2002) suggest that they play olfactory role in 4 Australian Cerocopidae, and their view is supported by Ranieri et al. (2016) data on Aphrophoridae, whose double-walled sensilla ceoloconica demonstrate the typical features of olfactory sensilla (spoke channels in the wall, several innervating neurons etc.). Thus, the double-walled coeloconic sensilla in *C. sanguinolenta* (plate fig. 40E) are likely olfactory, whereas the data by Ranieri et al. (2016) suggest that the single-walled coeloconic sensilla (plate fig. 40D) are thermo- and hygroreceptors.

The flagellum which consists of 3 segments in *Cicadella viridis* is unique among representatives of Auchenorrhyncha in our study that all had single-segmented flagella. Although, this character might not be constant within Cicadellidae, since Stacconi & Romani (2012) who studied *Scaphoideus titanus* (a cicadellid from another subfamily than *C. viridis*), found that its flagellum is single-segmented although pseudosegments do exist. The numerous pores in the surface and a moveable socket of trichoid sensilla of *C. viridis* (plate fig. 41 B, C) provide evidence that their function is most likely olfactory and mechanosensory. This is confirmed by observations of of Stacconi & Romani (2012) who found 3 sensilla ("long and short basiconica") with the same porose structure and similar location in *Scaphoideus titanus*. However, coeloconic sensilla that were found by Stacconi & Romani (2012) and suggested to be thermo- and hygroreceptors based on their structure, were not discovered in *Cicadella viridis*. Observations of the cited authors on campaniform sensilla in *S. titanus* correspond well with our data on *C. viridis.*

Fulgoromorpha. Aljunid & Anderson (1983) have shown for *Nilaparvata lugens* (Delphacidae) the same types of sensilla that were found in the present study in *L. striatella*; they also could demonstrate in TEM that the chemosensitive trichoid sensilla conceal three different types, one of which is olfactory (as in plate fig. 42c) and the other two most likely gustatory. Zhang et al. (2016) investigated the delphacid *Sogatella furcifera* and found mostly the same sensillar configuration as in the study by Aljunid & Anderson (1983) or in the present study. Our data on antennal structure of *Laodelphax striatella* correspond well with those of Fu et al. (2012) who studied the antenna of this species in greater detail. The most important differences to our study are: the petiole of the flagellum which was not visible in our specimens but clearly demonstrated by Fu et al. (2012); and basiconic sensilla similar to those found on the base of the flagellum that were found by Fu et al. (2012) to occur also in several copies on the pedicel. As for the opinion of the aforementioned authors that the flagellum in *L. striatella* consists of several segments, it is not supported here, since no segment boundaries were seen in the present study (plate fig. 42) or actually demonstrated by Fu

et al. (2012). The trichoid sensilla of *L. striatella*, with their poreless surface and flexible sockets (= sensilla chaetica of Fu et al., 2012), are clearly mechanoreceptors (plate fig. 43 b, d.); the basiconic sensilla (= sensilla trichodea of Fu et al., 2012) and plaque organs that have finely porose surface are most likely olfactory sensilla. As for the three basiconic sensilla on the base of the flagellar arista, Fu et al. (2012) consider them thermo- and hygroreceptors, putting them to the "poreless sensilla with inflexible socket" type of Altner & Prillinger (1980) and their interpretation is supported by a study on another Delphacidae, *Hyalestes obsoletus* (Romani et al., 2009) where the typical 3-cell-innervation in the sensilla (denoted as styloconic by the authors) was found. Still, it is not possible here to make definitive conclusions on their function until more research is done. As for the coeloconic sensillum that Fu et al. (2012) found close to the three basiconic sensilla of the flagellum base (and that is suggested to be thermo-, hygro- and chemosensitive by them), in our specimens the flagella were too collapsed and the coeloconic sensilla not visible. The "peculiar structures" of Fu et al. (2012) that are considered sensilla by the authors are interpreted in the present study as glands and are discussed in the respective chapter. Romani et al. (2009) found out that at least in *H. obsoletus* the cavity (named "Bourgoin's organ" by Cobben, 1987) in truth harbours not one, but two sensilla – one double-waled and one grooved-peg coeloconic. The double-walled sensillum is probably bimodal olfactory-thermohygrosensitive, whereas the grooved-peg sensillum shows close similarities to the CO2-sensillum of an ant and is supposed to play analogous role (Romani et al., 2009).

The present study of *Issus coleoptratus* is the first piece of information on antennae in this species. A comparison with a recent study on antennae of *Dentatissus damnosus* by Meng & Qin (2017) shows that the sensillar configuration on the antenna in these two species is very similar. The multiporous sensilla basiconica (called "sensilla trichodea" by Meng & Qin, 2017) of the pedicel and multiporous plaque organs (plate fig. 45) are most likely olfactory and the socketed non-porous trichoid sensilla of the pedicel mechanosensory, just like in *L. striatella*; the interpretation of their function by Meng & Qin (2017) is identical to the one presented here. The only difference to the present study is the basal pore on the multiporous sensilla basiconica (= trichodea in Meng & Qin, 2017) that was not found in *I. coleoptratus*. As for the coeloconic sensilla of the Bourgoin's organ and the three basiconic sensilla on the base of the flagellum, no definite conclusions concerning their function can be made here, although the overall similarity of *I. coleoptratus* antenna and e.g. that of *H. obsoletus* (Romani et al., 2009) suggests that these structures could play the same role as in *H. obsoletus*. It has to be said that the antennal architecture and sensilla types seem to be very similar between various taxa of Fulgoromorpha. Pedicel with olfactory plaque organs, olfactory basiconic sensilla and mechanosensitive trichoid sensilla and a flagellum with three basiconic sensilla and Bourgoin's organ that harbours two coeloconic sensilla: this architecture has been discussed above for several representatives of Delphacidae; Liang (2001a) found it also in Achilixiidae and Wang et al. (2014) in a Tropiduchidae. This architecture might be common to all Fulgoromorpha, although Tettigometridae (Bourgoin, 1985) and some Tropiduchidae (e.g. Wang et al., 2013) were demonstrated not to possess the three basiconic sensilla on the flagellum. An interesting difference can be seen in the structure of the Bourgoin's organ – it has a single cavity in Delphacidae (Romani et al., 2009), Tettigometridae (Bourgoin, 1985) or Tropiduchidae (Wang et al., 2013) that harbours two coeloconic sensilla, whereas in *Issus coleoptratus* (fig. 44b) or Achilixiidae (Liang, 2001a) each one of those has its own opening.

Heteroptera. Literature on antennal architecture and sensillar configuration in Heteroptera is moslty limited to Pentatomomorpha and some economically relevant taxa of Cimicomorpha. Thus,

absolutely no data are available in literature on fine structure of the antenna in Dipsocoromorpha, although their typical thin and long flagella with long setae are among the diagnostic characters of the infraorder (Štys, 1995). The presented information on the antenna *Ceratocombus* sp. must be considered the first piece of data. Study under scanning electron microscope demonstrated only two sensilla types: the socketed trichoid sensilla that are found on all antennomeres are most likely mechanosensory, whereas the basiconic sensilla without sockets but with many fine grooves and pores could be olfactory. Still, these conclusions must be considered only preliminary until ultrastructural analyses on the antennae are done.

In *Saldula saltatoria*, the socketed trichoid sensilla occurring on all antennomeres are most likely mechanosensitive. The grooved basiconic sensilla (type 3) are, due to their striking similarity to antennal sensilla in Cimicomorpha: Miridae (Chinta et al., 1997), Cimicomorpha: Reduviidae (Diehl et al., 2003) or Pentatomomorpha: Scutelleridae (Romani & Rossi Stacconi, 2009) can be considered olfactory, since sufficient evidence had been presented for that function in the sensilla by the mentioned authors. The basiconic sensilla of the type 2., judging by their paucity and obvious lack of pores, could be thermo- and hygroreceptors of the "no pore, Inflexible socket" type (Altner & Prillinger, 1980). The function of the basiconic sensilla type 1 is not clear, as well as that of the presumable sensillum coeloconicum (plate fig. 48a). Sinitsina & Chaika (1998) studied i.a. the antenna of *Saldula arenicola* and found sensillar configurations that are similar to *S. saltatoria*, although reasonable comparison of their results with those of the present study is not possible since the authors provided no details, illustrations or clues to the possible functions of the sensilla.

Sinitsina & Chaika (1998) also present some information on antennal sensilla of a tingid (*Physatocheila costata*), again without much specification, but their results from the table 3. correspond well to ours, although Sinitsina & Chaika (1998) use somewhat different designations for the sensilla types. The trichoid sensilla occurring on all antennomeres in *Corythucha ciliata* are most likely mechanoreceptors; the two multiporous types of the basiconic sensilla on the flagellum (sbpI and II, plate fig. 49) and the grooved basiconic sensilla (sbg, plate fig. 49) have probably olfactory function. The role of the non-porose sensilla (sb-np, plate fig. 49) is yet uncertain, but thermo- and hygroreceptive one is not very likely due to large size and numbers of the sensilla. More probable is that the sensilla are multiporose (and thus olfactory), but the pores are not visible in SEM.

Sinitsina & Chaika (1998) studied antennal sensilla in *Pyrrhocoris apterus*, but do not provide any details apart from naming the sensilla types that were found; hence, the comparison of their results with those of the present study is quite impossible. The sensilla trichodea I and II (plate fig. 50 B, D), with their sockets and lack of pores are most likely mechanoreceptors; st II seem to correspond to the "Tasthaare" that Gaffal & Hansen (1972, fig. 1.) found of the terminal flagellomere in *Dysdercus intermedius*. St III (plate fig. 50 B), also socketed and therefore mechanosensitive, have porose surface and probably combine mechanical and olfactory senses. They look similar to both "Riechhaare" ("olfactory hairs") and "Schmeckhaare" ("gustatory hairs") of Gaffal & Hansen (1972); it can be that this morphological type conceals sensilla of yet another function, e.g. gustatory. The grooved sensilla basiconica (sbg, plate fig. 51C) are most likely olfactory, based on data by Chinta et al. (1997), Diehl et al. (2003) or Romani & Rossi Stacconi (2009). The role of sensilla coeloconica I and II (plate fig. 51D-E) is not quite clear, but their structure seems similar to the typical thermo- and hygroreceptors (Altner & Prillinger, 1980) and will correspond well with results of amputational

experiments by Madge (1965) who found that response to changed humidity was impaired in individuals without the last antennomere (and coeloconic sensilla were only found on the last antennomere of *P. apterus*, although Madge himself suggests the hygroreceptive role in some basiconic sensilla on that segment).

Patterns of antennal sensilla in Hemiptera. Kristoffersen et al. (2006) mentioned that carrot psyllid (Sternorrhyncha: Triozidae) had only low numbers of olfactory sensilla (and hypothesized that they'd need high stimuli concentrations to respond). Onagbola et al. (2008) found slightly more than 60 sensilla (all types) on the 10-segmented antenna of a Sternorrhyncha: Psyllidae; whereas Romani et al. (2009) are wondering about low numbers of sensilla on flagellum of *Hyalesthes obsoletus* (Fulgoromorpha: Delphacidae). Rossi Stacconi & Romani (2012) detect similar paucity of sensilla for *Scaphoideus titanus* (Cicadomorpha: Cicadellidae) and explain it by a fine tuning of sensilla to the specific volatiles of the host plant, whereas Ranieri et al. (2016) doubt that, since their study object, *Philaenus spumarius* (Cicadomorpha: Aphrophoridae), is an extremely polyphagous species, but exhibits the same very scarce sensillar configuration. If this discussion is considered in the view of the results of the present study, the paucity of the antennal sensilla seems to be the general rule among al subtaxa of Hemiptera (including Peloridiidae), with two important exceptions: pedicel of Fulgoromorpha and the antenna of Heteroptera. The discussion of the reasons and details of this arrangement is beyond the scope of this study, but this feature can be used as character in phylogenetic discussions.

The configuration of the pedicel in Fulgoromorpha seems unique among Hemiptera. The second antennomere in representatives of other subtaxa carries almost exclusively mechanoreceptive sensilla, whereas in planthoppers it is also beset with numerous olfactory sensilla, especially their distinctive plaque organs (plate figs. 43a, 45). Another interesting feature is the distribution of different antennal sensilla types: thus, placoid sensilla are known in all subtaxa of Hemiptera, except Heteroptera. Coeloconic sensilla are found on antenna of most Hemiptera, but are absent from Heteroptera (*Ceratocombus* sp., *Saldula saltatoria*), except for the derived Pentatomomorpha (e.g. *Pyrrhocoris apterus*); Sinitsina & Chaika (1998) also found them among the most Pentatomomorpha studied by them, but besides that only in *Rhodnius prolixus* (Cimicomorpha: Reduviidae), *Anthocoris nemorum* (Cimicomorpha: Anthocoridae) and *Velia saulii* (Gerromorpha: Veliidae). Campaniform sensilla are found on pedicel in Sternorrhyncha (not seen in *Psylla alni*, but described for Triozidae by Kristoffersen et al., 2006), *Cercopis sanguinolenta*, *Cicadella viridis* (plate fig. 41B), *Laodelphax striatella* (Fu et al., 2012), *Issus coleoptratus* (plate fig. 44b) and are known from other representatives of Auchenorrhyncha – but were not found in Peloridiidae or Heteroptera (although they are described on pedicel in Cimicomorpha: Reduviidae by Weirauch, 2003, and on flagellum in Pentatomomorpha: Coreidae by Gonzaga-Segura et al., 2013). All these patterns are suitable as characters for phylogenetic analysis.

Labium tip

Sternorrhyncha. For Psyllidae, there is a study by Garzo et al. (2012) who record the same number and configuration of labial sensilla for the Asian citrus psyllid *Diaphorina citri* as was found in our study for *Psylla alni*, but the authors did not undertake any attempts to study the functions of the

sensilla or their finer structure. Sensillar configuration of the labium in aphids is very similar to that in psyllids, differing only in a higher number of the sensilla - e.g. 7 in *Pseudessigella brachychaeta* (Kanturski et al., 2017) or 8 in *Brevicoryne brassicae* (Tjallingi, 1978). In both cited cases, there is an outer circle of 5 (Kanturski et al., 2017) or 6 (Tjallingi, 1978) sensilla and two inner sensilla on each side – a configuration similar to *Psylla alni* and *Diaphorina citri* (Garzo et al., 2012), strongly reminding the condition in Peloridiidae and (when compared with the sensillar configuration in other studied taxa) suggesting a significant reduction. Tjallingi (1978) also studied the sensilla using transmission electron microscopy and electrophysiological methods; he found that their role must be purely mechanosensitive, since they were innervated by a single neuron and did not show reaction to any chemical substances. This might indicate that sensilla in *Psylla alni* might also be mechanosensitive since they were found to lack any pores in our study, but this needs to be studied with methods of transmission electron microscopy before it can be stated with certainty.

Cicadomorpha. Liang & Jiang (2001) recorded "12 peg sensilla" for the labium tip of a Cercopidae, Liang et al. (2006) noted "12 peg sensilla" in another Cercopidae genus. Apart from those very brief accounts, no data were found in literature on sensillar configuration of labium in Cercopidae. No species of *Cercopis* has obviously been studied until now, the actual study providing the first piece of information. The sutural group of 8 trichoid sensilla must have a combined mechanosensory-olfactory function, as their moveable sockets and finely porose surface indicate (plate figs. 54 B-C) – with the exception of the sensillum 5 that has large terminal pores instead of finely porose walls and is most likely gustatory-mechanosensitive. The peripheral semicircle of 6 long socketed trichoid sensilla and the 3 antisuturally located trichoid sensilla are most likely purely mechanosensitive. However, no definitive conclusions can be drawn here until ultrastructure of the sensilla is studied.

In contrast to stylet structure or cibarial and epipharyngeal sensilla that were studied in Cicadellidae by e.g. Tavella & Arzone (1993) or Backus & McLean (1983), the sensilla of labium tip did not receive much attention. The actual account might be the first piece of information on the subject provided for the species *Cicadella viridis* and Cicadellidae. Similarities to *C. sanguinolenta* are remarkable: as in that species, *C. viridis* has 8 (or probably 9) sensilla in the sutural group, where one of them is clearly different in structure from the rest (sb2 in *C. viridis* and number 5. in *C. sanguinolenta*). All of the sensilla in the sutural group of *C. viridis* might have a gustatory role (sb1 has the complicated tip structure suggesting a pore complex, whereas sb2 has a large terminal pore). The peripheral trichoid sensilla (st1-3) are most likely purely mechanosensory – again, similar to *C. sanguinolenta*. However, the differences between the two species are clear in the fine structure, configuration and number of the sensilla. Also, pores on the labium tip were found only in *C. viridis*, these pores might be the orifices of "simple" integumental glands.

Fulgoromorpha. In contrast to many other Auchenorrhyncha, mouthparts of Delphacidae were subject of quite a number of studies (discussed below), probably due to the economic importance of the family. Still, the present study contains the first data on labial sensilla in *Laodelphax striatella.* Foster et al. (1983) found in the delphacid *Nilaparvata lugens* exactly the same number and configuration of sensilla that was demonstrated for *L. striatella* in the actual study. Hence it is possible to hypothesize on the functions of sensilla in *L. striatella* with considerable degree of certainty. Sensilla st1 and st4 (plate fig. 58 A, D) would in this case be innervated by a single neuron terminating at the base of the sensilla in a tubular body (Foster et al., 1983) and thus be typical

mechnoreceptors, along with the sensillum basiconicum on the antisutural region (plate fig. 58B). Their long tips and absence of vicible pores (plate fig. 58A, D) correspond well with this supposition. Sensilla st2 and st3 would be combined mechanosensitive-gustatory, which also corresponds well with their terminal pores (plate fig. 58C). spla (plate fig. 58A, D) is, as its multiporous surface suggests, an olfactory sensillum, whereas the sensillum coeloconicum with the large middle pore (sco in plate fig. 58A) would be a gustatory sensillum. Only the interpretation of the triangular process on the antisutural margin of the labium orifice differs – Foster et al. (1983) have found it is innervated by a single neuron terminating basally and is thus a typical mechanoreceptor, whereas in the present study this part does not look like a typical trichoid sensillum, instead having a structure reminding of a single-porous gustatory sensillum (plate fig. 58B). Still, in the case of *Laodelphax striatella* the structure might be distorted by artefacfts during preparation for SEM. Dai et al. (2014) have found essentially the same configuration of sensilla in the delphacid *Sogatella furcifera* (except for the sensillum coeloconicum) as in *N. lugens* (Foster et al., 1983) or *L. striatella*; Brożek & Bourgoin (2013) demonstrated exactly the same sensillar configuration for a delphacid as did Foster et al. (1983) or the actual study. Bearing this similarities in mind, it can be hypothesized that the 11 sensilla on the sutural region, where 3 are pure mechanoreceptors, 6 are gustatory-mechanosensitive, 1 gustatory and 1 olfactory, and two sensilla on the antisutural region build the typical sensilla pattern for the family.

As for Issidae, their labial sensilla were not studied very often. Brożek & Bourgoin (2013) showed 13 sensilla in the sutural group and 2 in the antisutural one for *Trienopa paradoxa*, albeit the labium tip was prepared quite poorly and the authors did not attempt to study unltrastructure of the sensilla. The sutural group of *T. paradoxa* contains only 13 sensilla (in contrast to 19 in *Issus coleoptratus*, plate fig. 59B), and no outer circle of socketed trichoid sensilla was described for that species (but is present in *Issus coleoptratus*, plate fig. 59B). However, Gnezdilov (2009) notes that *Trienopa* actually belongs to Tropiduchidae and not to Issidae, thus the differences to *Issus coleoptratus* are understandable. The undoubted issid *Dentatissus damnosus*, studied by Meng & Qin (2017), shows a sensillar configuration very similar to *I. coleoptratus*. *D. damnosus* has a total of 20 sensilla (21 in *I. coleoptratus*) and the sutural group also consists of sensilla of two distinct morphologic types (uniporous peg-like sensilla and sensilla basiconica subtype II, in terms of Meng & Qin, 2017). The trichoid sensilla of the outer circle in *I. coleoptratus* are most likely purely mechanosensitive, although ultrastructural studies are needed to confirm that. The basiconic sensilla of the type 1 (plate fig. 60A-B) are probably of mixed olfactory-gustatory function, as their multiporous surface and tip structure indicates. Their position implies homology to uniporous peg-like sensilla in *D. damnosus* (Meng & Qin, 2017) that are supposed by the authors to be i.a. tactile receptors. The basiconic sensilla of the type 2 in *I. coleoptratus* (plate fig. 60C) are probably only gustatory, since their tips suggest a pore complex, but the surface is not porose. They correspond to the basiconic sensilla of the subtype 2 in *D. damnosus* (Meng & Qin, 2017) that are considered mechanorecpetive by the authors. Meng & Qin's interpretation of the very similar morphological data is quite different to the one presented here; both views might be justified, but ultrastructural studies on the sensilla are needed before anything can be stated with certainty. The probable function of the two basiconic sensilla on the antisutural margin of the labial orifice (sb3 and 4, plate fig. 95D) is not clear, but they definitely come in contact with the stylet bundle and thus might help in coordination of its movements; Meng & Qin (2017) interpret them similarly.

A sutural group of some dozen of sensilla with gustatory, olfactory and mechanosensitive function and an antisutural group consisting of only 2, likely pure mechnoreceptors, seems to be common to both *L. striatella* and *Issus coleoptratus*. Brożek & Bourgoin (2013) share this opinion, suggesting the 13 sensilla in the sutural + 2 in the antisutural group as the ground plan of Fulgoromorpha. 10 sb1-sensilla of *I. coleoptratus* might be homologous to the sutural group in *L. striatella* (11 sensilla), due to similar form and olfactory-gustatory affinities – although this is mere speculation and needs further evidence.

Heteroptera. Available literature does not contain any details on labial sensilla in a *Ceratocombus* (actually, in any species of Dipsocoromorpha), this thesis providing the first piece of information on the matter. The multiporous central oblong sensillum (plate fig. 62A-B) with the delicate cuticle is most likely olfactory; those of the placoid sensilla surrounding it that possess a central pore are probably gustatory, whereas the function of the rest of the placoid sensilla is not yet clear. Ultrastructural evidence is needed, before any definite conclusions can be drawn here.

Cobben (1978, pp. 70, 74, fig. 115) already provided some details on the labium tip in *Saldula lugubris*, but the labial sensilla were beyond the scope of his study and hence Cobben (1978) did not deliver much information on them. The results of the present study correspond well with his fig. 115, in but one point. Cobben reports on an apical plate that was not found in *Saldula saltatoria* (plate fig. 64A), although Cobben indicates that it might be obscured by ventral folds of the cuticula. As for the sensilla functions, the long multiporous placoid sensillum is most likely olfactory, whereas the placoid sensilla with a central pore are probably gustatory; the role of the coeloconic sensillum is elusive. All in all, the sensillar configuration of *S. saltatoria* is quite similar to *Ceratocombus*, which might indicate either relatedness or convergence due to similar predatory lifestyle. As in *Ceratocombus*, ultrastructural studies are needed before anything certain can be said about the function of the sensilla.

It is surprising that no information was found in literature on labial sensilla in such an economically important taxon as the Tingidae, so the present study seems to provide the first piece of data on that matter. However, little can be said on sensilla of *Corythucha ciliata* apart from their habitus. Details of their structure (plate fig. 66) do not allow even preliminary conclusions, since the sensilla lack porose surface, terminal pores or moveable sockets. The function of the "stellar structure" (plate fig. 66A) is absolutely elusive.

In contrast to the previously treated heteropterans, the labial sensilla of the Pyrrhocoridae received significant attention from morphologists and systematists (Shoonhoven & Henstra, 1971; Peregrine, 1972; Gaffal, 1981; Wang & Dai, 2017). The morphology and configuration of the basiconic labial sensilla in *P. apterus* that was studied here is almost identical with that of *P. sibiricus* studied by Wang & Dai (2017). Schoonhoven & Henstra (1971), who investigated two representatives of the genus *Dysdercus* (*D. fulfoniger* and *D. koenigii*), found not basiconic 12 sensilla as in the present study or that by Wang & Dai (2017), but 13. Comparing the results, it seems that the sensillum C of Schoonhoven & Henstra (1971) (= C2 of Gaffal, 1981) is absent in both *Pyrrhocoris* species. The porose basiconic sensilla (sbp in plate fig. 68) of the present study seem to have several pores on the tip, whereas Shoonhoven & Hentsra describe their homologues as having only one terminal pore and interpret them as contact chemoreceptors. Peregrine (1972) in his study of labial sensilla of

Dysdercus fasciatus complements the data of Schoonhoven & Henstra (1971) by demonstrating that the basiconic sensilla of the labium tip have both an apical pore and multiple wall pores and could thus be both gustatory and olfactory in function. It does remind of the condition of the coeloconic sensilla in some species of Peloridiidae (plate fig. 17C) that seem to have both apical and wall pores, too. Schoonhoven & Henstra (1971) also describe the numbers of neurons that occur in different sensilla on the rostrum in *Dysdercus*. Their sensilla A5 and A9 are most likely homologous to the double-walled basiconic sensilla in the present study (sb-dw in plate fig. 68) and Sb IV9 and 10 by Wang & Dai (2017). Since A5 and A9 by Schoonhoven & Henstra are innervated by 3 neurons, this could be an indication of the role for the respective sensilla as thermo-hygroreceptors that are typically innervated by 3 neurons (Altner & Prillinger 1980)

Considering the labium of all studied Heteroptera species and its sensillar configuration, it appears as if all of the labial sensilla (with the exception of the peripheral trichoid ones in *P. apterus*) are homologous to the sutural group in Auchenorrhyncha. The antisutural region in Heteroptera is generally reduced (compare e.g. the labium of *P. apterus* or *C. ciliata* in plate figs. 67 and 65, respectively, with that of *L. striatella* or *C. viridis* in plate figs. 57 and 55, respectively). The number of sensilla in the sutural group is also very similar, with 8 in *C. sanguinolenta* and *C. viridis*, 10 in *Ceratocombus*, 11 in *L. striatella*, 12 in *S. saltatoria*, *C. ciliata* and *P. apterus*; the only exception here being *I. coleoptratus* with 19 sensilla. Most of them seem to be gustatory or olfactory in function. It can be suggested that the sutural group with 10-12 chemosensory sensilla belongs to the ground plan of Hemiptera. The condition in the known Sternorrhyncha (e.g. *P. alni* with only 4 sensilla, most likely purely mechanosensitive) and probably Peloridiidae too (7 sensilla, most of them probably purely mechanosensory) seem to represent a reduction of the ground plan. However, mouthparts of more representatives of Hemiptera, in the first place Cicadomorpha, Heteroptera and Sternorrhyncha, must be studied to test this hypothesis.

4.2.2.2 Characters of the thorax

Surface sculpture of tegmina

Reports on surface tegmina sculpture in Hemiptera are not very abundant in literature. Simon (2013), although focusing on other topics, provided two SEM pictures of the tegmina of male *Pulvinaria vitis* (Sternorrhyncha: Coccidae) that suggest that the tegmen is uniformly covered with hair-like microtrichia (unfortunately, it is not clear whether the surface she studied is ventral or dorsal). Sun et al. (2011) described nano-sized sculpture in 20 different cicada species, although again did not specify if the studied surface was the dorsal or the ventral one. Besides, the surface structures described by them are much smaller and most likely not homologous to microtrichia and acanthae concerned here. Schuh & Weirauch (2010) in their study of some Australian Phylinae (Heteroptera: Cimicomorpha) provided SEM photographs of some dorsal tegmina surfaces where dense cover of hair-like microtrichia with more sparse trichoid sensilla can be seen in all treated species. Czaja (2013) was the only author to study surface microtrichia patterns on tegmina of Scutelleridae (Heteroptera: Pentatomomorpha) purporting to use them in systematics. She was able to identify

several patterns that provide interesting insights into systematics of the family. However, tegminal surface sculpture has never before been studied Hemiptera-wide in a broad phylogenetic context.

The function of the tegminal sculpture is not very clear. Sun et al. (2011) and Hartung et al. (2016) demonstrated their water-repellent properties for cicadas and Peloridiidae, respectively (although, again, the structures they studied might not be homologous to each other). Sun et al. (2011) also pointed at the structure's ability to reduce light reflection. Czaja (2013) has shown that in Scutelleridae the sculpture was more pronounced in species with heavier sclerotized tegmina. However, the information is scarce and more studies on the matter are needed before reasonable functional explanations can be developed.

Hind tibia and tarsus

The literature data on SEM studies of the tarsi and distal tibiae in Hemiptera is not very extensive. Friedemann & Beutel (2014) and Friedemann et al. (2014) studied pretarsal structures in representatives of Sternorrhyncha (all 4 superfamilies: Aleyrodoidea, Aphidoidea, Coccoidea and Psylloidea), Auchenorrhyncha (Cercopidae, Cicadidae, Membracidae, Cixiidae, Delphacidae and Dictyopharidae) and Heteroptera (Ceratocombidae, Schizopteridae, Enicocephalidae, Pentatomidae), as well as the peloridiid *Hackeriella veitchi*. Chen & Yang (1995) studied the hind tarsi in various representatives of Fulgoromorpha. Liang et al. (2005) provided SEM pictures of tarsi in the Australian Aphrophoridae genus *Anyllis,* and Cwikla & Freytag (1983) did the same for the cicadellid *Xestocephalus subtessellatus*. Schuh (1976) demonstrated the diversity of pretarsal structures in Heteroptera: Miridae and applied the acquired (or freshly reviewed) information to the systematics of the group. Weirauch (2005) provides a plenty of information on pretarsus in Reduviidae, and the extensive oeuvre of Cobben (1978), although dealing primarily with mouthparts and feeding strategies in Heteroptera, does provide much information on tarsal structures in various groups of Hemiptera. Goel & Schaefer (1970) studied pulvilli in many heteropteran groups, whereas Goel (1972) provides information on unguitractor structure in various true bug taxa. Finally, Barao et al. (2013), Lis (2010), Lis & Ziaja (2010) and Lis et al. (2002) treat tarsal and tibial structures in different families of Heteroptera: Pentatomoidea.

Our results correspond well with the most findings by the aforementioned authors; the points where our opinions diverge are discussed below.

Contact zone. The contact zone of the arolium was found by Friedemann & Beutel (2014) in all Auchenorrhyncha species studied by them, both Cicado- and Fulgoromorpha; the contact zone is the terminal region with a specially structured thickened cuticle that plays an important role in attachment to the substrate. In another paper, Friedemann et al. (2014) somewhat confusingly name apparently the same structure "sticky terminal lip", and in their data matrix it is only found in Fulgoromorpha. In our study, contact zones are well visible not only in *I. coleoptratus* (plate fig. 82), but also in *C. sanguinolenta* (plate fig. 79) and on both parts of the bilobed arolium in *C. viridis* (plate fig. 80). However, no typical contact zone was found in the delphacid *L. striatella* (plate fig. 81), although Friedemann & Beutel (2014) in their description of Delphacidae do mention a contact zone. It seems that the contact zone might be an integral part of the arolium in Auchenorrhyncha, but

more representatives of both Cicado- and Fulgoromorpha should be studied to test this assumption. Anyway, a contact zone/sticky terminal lip on the arolium cannot be an autapomorphy of Fulgoromorpha, as Friedemann et al. (2014) suggested.

According to Friedemann et al. (2014), the arolium in *Cercopis vulnerata* has a median incision. Our data on the closely related *C. sanguinolenta* that has a single-lobed arolium (plate fig. 79c) suggest that the median incision might be an artefact due to an incomplete inflation of the structure.

The membranous inflatable organ on the first tarsal segment in *Psylla alni* (plate fig. 78b) was not reported before. The details of its structure suggest a role in attachment to substrate. It is provisionally referred to as "euplantula" here, since this term is applied in Capinera (2008) to pad-like adhesive appendages on tarsi (although Friedemann et al., 2014, give a slightly different definition).

Pulvillus. If one considers the patchy distribution of the pulvilli among the Hemiptera (Friedemann et al., 2014) or some of its subgroups (e. g. Schuh, 1976), it seems likely that these structures are not homologous and could have been developed several times independently. There are at least two different definitions of pulvilli in literature: Friedemann et al. (2014) speak of "smooth or hairy paired lateral membranous lobes ventral to the claws. They are located on the auxiliae, which participate in control of pulvillar movements." Cassis & Schuh (2010) define pulvilli as "fleshy pads… which can arise from the base… or from the ventral or medial surface… of the claws". As the reader can see, even the insertion of pulvilli is defined differently, and the specific quality is outlined all too nebulous if at all. It is thus not surprising that the findings of the present study are interpreted here differently than that is done in some literature sources. We found pulvilli in two species that are treated here: the sternorrhynchan *Psylla alni* and the derived heteropteran *Pyrrhocoris apterus*. With taxa set on such distant branches of the evolutionary tree it is temptating to consider the structures non-homologues, as e.g. Friedemann et al. (2014) do. They interpret the paired attachment structures of a *Cacopsylla*, a genus closely related to *Psylla,* as bilobed arolium. However, if one considers the position of the typical bilobed arolium in e.g. *Cicadella viridis* (plate fig. 80) and the attachment structures of *Psylla alni* (plate fig. 78), the differences are obvious. In *C. viridis*, the arolium, although bilobed, clearly constitutes an entity; it is set distad from the unguitractor and mediad from the claws. In *P. alni*, both attachment structures are separated by sclerotized region well visible dorsally (plate fig. 78d), and are inserted on lateral/dorsal sides of the claws. Furthermore, the arolium of *C. viridis* is inflatable, whereas the structures in *P. alni* are quite rigid and do not change the form significantly when exposed to changing osmotic pressure. At the same time, the lamellar structure of the pulvilli in *P. alni* does not look dissimilar to that in *P. apterus* (plate fig. 86c), and one also has to bear in mind the pulvilli in Eccritotarsina (Heteroptera: Miridae) that are also inserted on the medial side of the claw. Another argument in favor of our view is the fact that pulvilli have been recorded for all other major groups of Sternorrhyncha, i.a. in the study by Friedemann et al. (2014), which makes it plausible for representatives of Psylloidea to possess pulvilli as well. The last but not least, Ossiannilsson (1992) in his comprehensive treatment of Psylloidea of Fennoscandia (p. 16) also treats the pretarsal appendages of jumping plant lice as pulvilli. Considering all the evidence, the attachment structures of *P. alni* are treated as pulvilli here, defined as attachment structures that originate on the claws – although this definition is only provisional and ultrastructural studies of larger set of taxa are needed to solve this terminological and homological problem.

Parempodia. Parempodia are considered as absent in Tingidae by Goel & Schaefer (1970), but our results on *Corythucha ciliata* do show that they are present at least in this species. “Parempodium” is another term that leads to many considerations on homology of the strucrures in question. In the present study (after Goel, 1972; Cobben, 1978 and many other workers) only setiform sensilla that are set in alveoli (or at least structures that are easily deducible from such type) are considered true parempodia. However, all Heteroptera species in this study had socketless acanthae-like protuberances on the distal part of the unguitractor. For the lack of a better solution at the moment, these are not considered parempodia, but “accessory parempodia” (after Cobben, 1978, p. 113). Still, it is not inconceivable that a socketed setiform structure and an acantha can be homologous – s. e.g. the acanthous tibial spurs in adult Peloridiidae that are likely homologues of setae in larvae. The matter gets even more complicated when we consider the cases like *Saldula saltatoria* or *Pyrrhocoris apterus* where 2 pairs of appendages on unguitractor are found. It is also not clear at all if the accessory parempodia of Cobben (1978) and pseudopulvilli of Schuh (1976) are homologues. There is no generally accepted solution here at the moment; the socketed setiform sensilla on unguitractor are considered homologues in the present study and are referred to as parempodia, whereas the socketless acanthae are termed accessory parempodia and also considered homologues between the species, although the limitations of this concept are clear. If one considers that “arolium” is also a problematical term (see e.g. Weirauch, 2005, who voices reasonable doubts that arolia as they are known in some Heteroptera are homologous to those in Auchenorrhyncha), the need of the revision of pretarsal terminology in Hemiptera (and maybe in all Insecta) is obvious.

4.2.2.3 Characters of the abdomen

Surface of the dorsal abdomen

Psylla alni, Laodelphax striatella and *Issus coleoptratus* all possess the same structure of the dorsal abdomen as the Peloridiidae: peg-like microtrichia that are covered with wax-like secretion (that can be removed with chloroform). The role as a plastron has not yet been demonstrated for *P. alni* or both fulgoromorphans, but the structural similarities seem to suggest the homology of the concerned structures. The phylogenetic hypothesis discussed in section 4.4 implies that the water-repellent structures might represent a symplesiomoprhy of Hemiptera that disappeared in Heteroptera and Cicadomorpha. It has to be noted, that while the wax-covered microtrichia in *P. alni* are restricted to dorsal abdomen and some neighbouring regions of the thorax, which is very similar to the condition in Peloridiidae, the wax covering in *L. striatella* and *I. coleoptratus* is not limited to those regions and occurs almost everywhere on the body.

Abdominal sculpture is a character complex that is only seldom covered in literature. Dietrich (1989) studied sculptural elements in Membracidae (Auchenorrhyncha: Cicadomorpha) and already noted that they are of potential interest to systematists, demonstrating some taxonomic patterns of sculptural elements within the family. Unfortunately, his approach was not implemented further by other researchers. Studies of plastron structures in non-aquatic Hemiptera are also rare. Messner & Adis (1992) reported such from larvae of Cercopidae and Cicadidae (both Auchenorrhyncha:

Cicadomorpha). They also consisted of peg-like cuticular protuberances, but were located ventrally on the abdomen and not dorsally, as in Peloridiidae, *P. alni* or the both fulgoromorphans in the present study, and thus cannot be homologues to the plastron structures in those groups. Rakitov (2002) suggested that one of the functions of brochosomes in Cicadellidae (Auchenorrhyncha: Cicadomorpha) could we the creation of unwettable surface that protects the insect from honeydew and water – this would be yet another independent acquisition of a plastron by non-aquatic Hemiptera.

4.2.2.4 Characters of the general body surface

Integumental glands

The interpretations of structures described here for the outgroup taxa as integumental glands is based on the same line of reasoning as for Peloridiidae (Discussion, section 4.2.1.6): large pores and ubiquitous distribution on the body makes the role as chemosensilla unlikely, whereas morphological similarity to structures that were demonstrated to be glands suggests similar nature for the structures in question (Lawrence & Staddon, 1975; Cobben, 1978, p. 164; Fröhlich & Lu, 2013; Jia & Liang, 2015). Besides, as of yet the relevant structures were studied on the internal surface of the cuticula in *Corythucha ciliata* and *Aphrophora alni* (that is not on the ultimate list of outgorups for the present study, but was analyzed in preparation to it), and typical glandular ducts were found for both species (data not shown). The glands of *Aphrophora alni* are very similar to the structures of *C. sanguinolenta* (plate fig. 96) or type III of *Cicadella viridis* (plate fig. 97C); the analysis of glandular canals of those and some other species is ongoing. The issue of discerning glands from sensilla is not an easy one; many authors described structures that are most likely glands, but misidentified them. For example, Cwikla & Freytag (1983) describe in *Xestocephalus subtesselatus* (Cicadomorpha: Cicadellidae: Aphrodinae) structures very similar to those of *Cicadella viridis* (Cicadellidae: Cicadellinae) analyzed here. The authors identify them as “secretory pores (?)”, but mention that they also can be modified sensilla placodea. Hummel et al. (2006) described structures on female genitalia in *Homalodisca coagulata* (Cicadellidae: Cicadellinae) that are very similar to glands of *Cercopis sanguinolenta*; the authors interpret them as coeloconic sensilla in their study using light microscopy and SEM. Qi et al. (1995) describe the conspicuous integumental glands on abdominal tergites of several Tingidae species as “sensory structures”. The issue is not made easier by nomenclatural ambiguities, since there is no uniform name for the structures in literature: the glands are being called tegumentary glands, integumentary glands, integumental glands or dermal glands. It was decided to adopt here the name “integumental glands”, since a majority (if not an overwhelming one) of researchers was found to apply it and the term also does not have unnecessary connotations as e.g. “dermal glands” do.

Structure of integumental glands has been used in systematics of Hemiptera before (e.g. Foldi & Cassier, 1985), although mostly those were the wax glands that have been studied in this regard. Liang (2002) described taxonomic differences in wax glands on abdominal tergites 6-8. in *Kinnara* (Fulgoromorpha: Kinnariidae) and Liang & Song (2012) in some Dictyopharidae. Liang & O’Brien

(2002) describe wax gland plates in larvae of the Achilidae *Epiptera woodworthi* that have apperarance similar to those in larvae of *Issus coleoptratus*. They note that the wax gland structure in the achilid is similar to that in Cixiidae or Dictyopharidae, but different from other Fulgormorpha. Staddon & Ahmad (1995) used i.a. the structure of integumental glands for resolving taxonomic problems in *Piezodorus* (Heteroptera: Pentatomomorpha: Pentatomidae). However, the glands are extremely variable on a larger taxonomic scale (good illustration is the diversity of glands in Zygentoma and Microcoryphia shown by Matushkina, 2010) and thus have never before have integumental glands been used for phylogenetic analysis of higher taxa.

The gland structure found by Lawrence & Staddon (1975) in *Dysdercus fasciatus* (Heteroptera: Pentatomomorpha. Pyrrhocoridae) strongly resembles that in Peloridiidae, which could be an argument for relatedness of Coleorrhyncha and Heteroptera. Still, this feature has not been used in the phylogenetic matrix, since *P. apterus*, in contrast to the confamiliar *D. fasciatus*, only possessed simple glands. However, this fact is potentially interesting and should be remembered when constructing a more extensive character matrix.

4.3 Integrative evaluation of characters from fine morphology, bioacoustics, ecology and behavior

Jumping and tibial spurs

It was already supposed by Burrows et al. (2007) that the tibial spurs in Peloridiidae could provide the necessary grip with the substrate when jumping. This view is corroborated by the behavioral observations of the present study. 8 specimens on *Xenophyes cascus* in 5 hours of observation did not jump a single time. The two available living *Oiophysa cumberi* specimens were generally very inactive and tried to avoid desiccation at best by falling off the substrate. This behavioral results support the view of Burrows et al. (2007), since neither *Xenophyes cascus* nor *Oiophysa cumberi* have spurs on the distal hind tibiae. Another argument in favor of the role of the spurs in jumping is that these are only found on the hind legs that solely provide propulsion (Burrows et al., 2007). However, more specimens of more species still need to be tested in this regard, since the failure to observe jumping in the two species mentioned above could be caused by stochastic factors and cannot be regarded a proof.

Antennal sensilla in relation to diet

Compared with representatives of Fulgoromorpha, the cicadomorphans in our study as well as in available literature seem to have quite a sparse sensillar configuration – one-two dozens of sensilla in Cicadomorpha vs. much higher numbers in Fulgoromorpha. Peloridiidae are more similar to Cicadomorpha than to Fulgoromorpha in this respect, since they only have one placoid, 3-6 trichoid and up to a dozen of coeloconic sensilla. Rossi Stacconi & Romani (2012) suggest that a low number of olfactory sensilla is correlated with a smaller host range (few sensilla specializing on detecting

some very peculiar odorants). Ranieri et al. (2016) questioned this interpretation, since the highly polyphagous *Philaenus spumarius* in their study also had very few olfactory sensilla. Ranieri et al. (2016) suggest, contrary to the model of Rossi Stacconi & Romani (2012), that fewer sensilla are characteristic for less specialized herbivores: those would need just to find any plant, not a special one, and few sensilla would be enough for that. Peloridiidae, with their single placoid sensillum on the antenna and host plant ranges that embrace bryophytes from numerous families and even different classes, would rather fit the model of Ranieri et al. (2016) than that of Rossi Stacconi & Romani (2012).

Abdominal tergite 1. and acoustic signals

It is likely that the acoustic apparatus of Peloridiidae is a tymbal organ moved by longitudinal musculature, where first abdominal sclerites are involved (Wessel et al., 2014). In this regard, a comparison between the structure of the first dorsal tergite (T1) and acoustic signals of the species is interesting (table 6):

Geographic origin	**Species**	**Pulse frequency**	**Width/length of T1**
Australia	*Hackeriella veitchi*	Low (7-8 Hz)	1,7*
South America	*Peloridium hammoniorum*	Low (up to 4 Hz)	1,8
South America	*Peloridium pomponorum*	Low (up to 2 Hz)	2,2
New Zealand	*Oiophysa cumberi*	High (19-62 Hz)	4,3
New Zealand	*Xenophyes cascus*	High (41-51 Hz)	3,8

Table 6. Frequency of acoustic signals in Peloridiidae vs. the relative width of the 1. abdominal tergite (the sclerotization of T1 bordered by cuticular thickenings was measured). Asterisk in *H. veitchi* denotes that data on T1 in this species were not available; instead, those of the closely related *Hackeriella brachycephala* were used.

Although acoustic data are available for only several species, a correlation is obvious: species with broader and shorter T1 (e.g. plate fig. 29b) sing with a higher frequency than species with longer and thinner T1 (plate fig. 29a). It makes sense to try predicting the frequency of acoustic signals in the species where they are yet untested: if the considerations presented here are right, all New Zealand species (who have high relative width of T1) would produce signals with higher pulse frequency, whereas all species from Australia and South America would use lower frequencies. This hypothesis certainly deserves attention in future bioacoustics studies. However, if the posterolateral apodemes are crucial in signal production, than the pulse frequency of *Xenophysella* could be more similar to those of *Hackeriella* and *Peloridium*, since these apodemes in *Xenophysella* are more similar to Australian and South American representatives than to other New Zealand species (Supplement 3., fig. 13 D-E).

Mandibular twist and feeding biology

The peculiar twist of the mandibular stylets in some Peloridiidae (plate fig. 16) could imply some dietary peculiarities correlating with this morphological trait. However, no pattern could be found after comparison of host plant ranges and mouthparts of different Peloridiidae. For instance, both genus *Peloridium* and *Xenophyes* were found to have twisted stylets – but *Peloridium* in the present study was very selective, occurring almost exlusively on *Sphagnum* species or *Polytrichadelphus*

magellanus, whereas *Xenophyes* includes the least host-specific Peloridiidae of all (s. Diagram 3.). Thus, the explanation for this peculiar morphological trait must be searched elsewhere.

Unguitractor scales

Wide plates on unguitractor are considered by Gorb (1996) to be of help when the insect has to walk on thin rods. *Cicadella viridis* in the present study that lives on grasses was found to have only small scales on unguitractor, and the ground-dwelling predator *Saldula saltatoria* wide plate-like scales; this observation does not support the interpretation of Gorb (1996).

4.4 Phylogenetic analysis based on characters of fine morphology

In the strict consensus between the 6 phylogenetic trees delivered by the analysis in TNT (fig. 10), Peloridiidae, Auchenorrhyncha and Heteroptera are recovered as monophyla (Sternorrhyncha being represented by *Psylla alni* alone). It must be mentioned that the homoplasy level in the tree is quite high (Ci = 49, Ri = 67) and Bremer support values are mostly relatively low, many nodes collapsing after a single extra step. The sister-group relationship between Auchenorrhyncha and Peloridiidae has the strongest statistical support of all nodes (Bremer support value = 5). This is the first phylogenetic analysis of Hemiptera, carried out with morphologic characters and explicitly involving representatives of both Auchenorrhyncha and Heteroptera, that delivers support for a monophyletic grouping between Auchenorrhyncha and Peloridiidae/Coleorrhyncha. Until now, evidence for this association came mostly from molecular studies (Cui et al., 2013; Misof et al., 2014; Wang et al., 2015) or were not subjected to a formal cladistics analysis (e.g. Popov & Shcherbakov, 1996). It is worth mentioning that the character matrix was adjusted to test the robustness of the group Auchenorrhyncha + Peloridiidae. In one case, only the characters that had the same character state throughout the whole family Peloridiidae were left in the matrix; in another one, all the character states that were coded as missing (a "-") either in all outgroups or in all Peloridiidae were omitted (data not shown). In both cases the monophylum Auchenorrhyncha + Peloridiidae persisted.

The apomorphies that support the monophylum Auchenorrhyncha + Peloridiidae in the present study are the following (s. fig. 18):

- arolium present (character 10, state 1)
- setiform parempodia absent (character 21, state 0)
- flagellum base petiolate (character 31, state 1)
- olfactory placoid sensilla on the antenna present (character 34, state 1)
- microtrichia absent from dorsal tegminal sculpture (character 65, state 0)
- antisutural group of sensilla on labium tip present (character 86, state 1)
- multiporous sensilla on labium tip present (character 90, state 1)

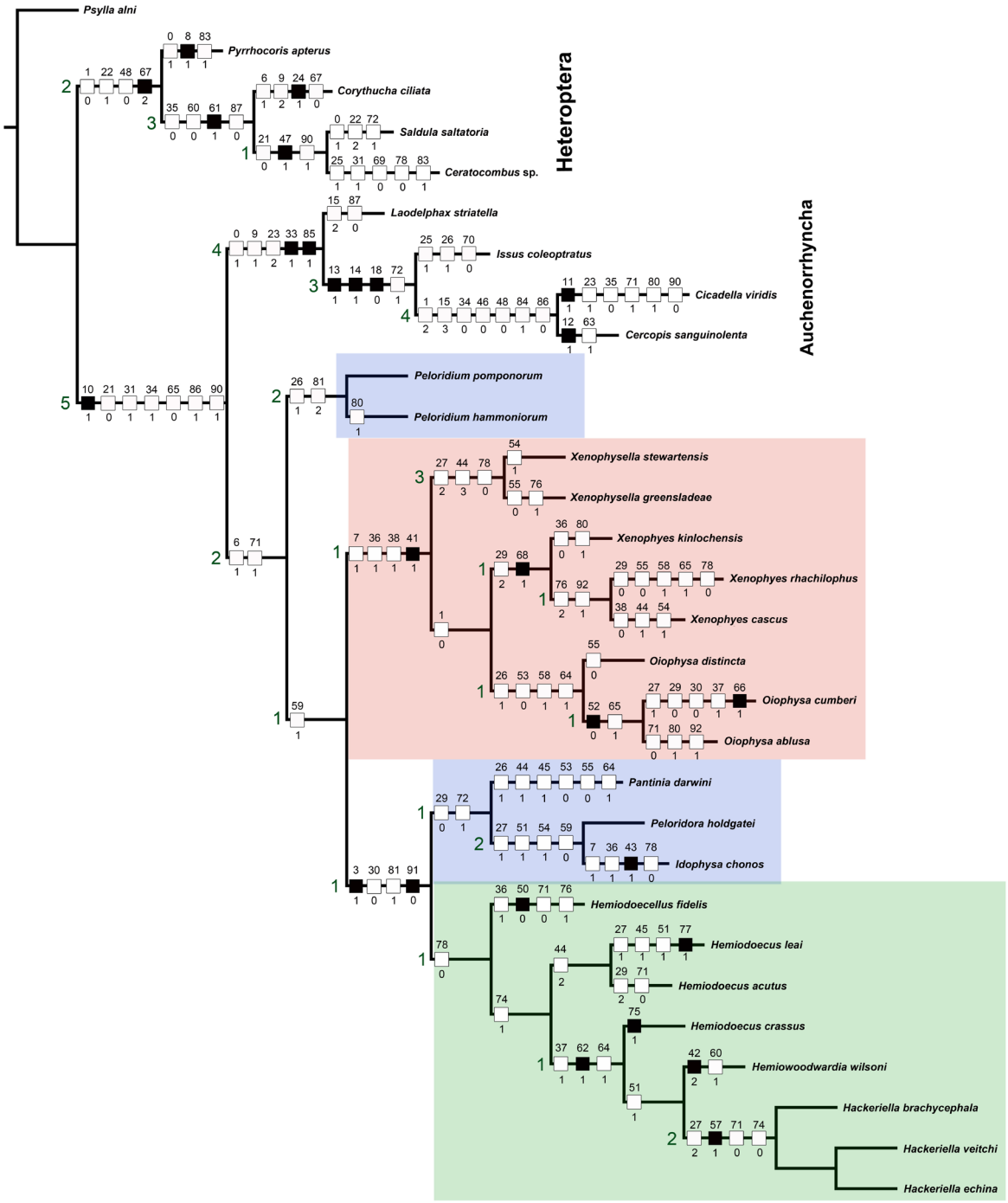

Figure 18. Figure 12. from the results section, with Peloridiidae species from different biogeographic regions highlighted in green (Australia), blue (South America) and red (New Zealand). Apomorphies of the clades are indicated as squares: empty for homoplasious, full for non-homoplasious. The number above the square is the number of the respective character from the matrix, the number below is the character state. Large green numbers before the nodes are Bremer support values (taken form the strict consensus tree).

All these characters are homoplasies in the present analysis, except for the arolium. However, even that might become homoplasious if e.g. other species of Ceratocombidae (Heteroptera: Dipsocoromorpha) would have been involved, since arolia are known from several representatives of Dipsocoromorpha, e.g. from the Oriental genus *Kvamula* (Štys, 1982). Thus, arolia might be a

symplesiomorphy for Auchenorrhyncha, Coleorrhyncha and basal groups of Heteroptera (Dipsocoromorpha are considered as one of the most basal taxa of the true bugs, s. Štys, 1995). The same is true for petiolate flagellum base that also has been found in *Ceratocombus* in the present study (plate fig. 46). The absent character states, as setiform parempodia or microtrichia that were not found in Auchenorrhyncha or Peloridiidae representatives analyzed in the present study, might also be symplesiomoprhies as compared to both characters that seem to have been developed only in Heteroptera. The character 86 relies on the interpretation of the inner circle of the sensilla of the labium tip in Peloridiidae as homologous to antisutural group of sensilla in Auchenorrhyncha – an interpretation that probably needs more support from independent sources of evidence and more detailed study. Even the characters 34 and 90 are not unambiguous: placoid sensilla on the antenna are not present in Cicadomorpha used in the present study[29] (only in Fulgoromorpha *Laodelpax striatella* and *Issus coleoptratus*), and multiporous sensilla on labium were also found in some representatives of Heteroptera (*Ceratocombus* sp. and *Saldula saltatoria*). It is worth noting that Dipsocoromorpha (where *Ceratocombus* sp. belongs to) and Leptopodomorpha (i. a. *Saldula saltatoria*) are considered among the more basal branches of the Heteroptera phylogeny (e.g. Wheeler et al., 1993; Weirauch & Štys, 2014). As in the case with arolia or petiolate flagellum, it makes a hypothesis plausible that basal branches of Heteroptera retain quite a lot of plesiomorphic character states. The support for the monophyletic group Auchenorrhyncha + Peloridiidae/Coleorrhyncha obtained in the present study needs more testing with more extensive taxon sampling and under inclusion of some previously elaborated character sets, as e.g. that of Friedemann et al. (2014).

Peloridiidae are recovered as monophylum, with two apomorphies (both homoplasious): setae on tarsus smooth (character 6, state 1) and peripheral elements of integumental glands differentiated into an inner and an outer circle (character 71, state 1). Smooth tarsal setae also were found in the heteropteran *Corythucha ciliata* and do seem a parallel development; the differentiation of peripheral elements is unique for Peloridiidae, but is obviously lost in some Australian representatives. Thus, these two characters probably constitute two previously unknown apomorphies for Peloridiidae.

The figure 18 was chosen to represent the phylogenetic relationships within Peloridiidae after comparison with two other previously published hypotheses (Popov & Shcherbakov, 1996; Burckhardt, 2009). First, both cited articles agree on *Hemiodoecellus fidelis* branching off most basally in the Australian clade. Second, Burckhardt (2009) obtained the genus *Xenophysella* on the most basal branch of the New Zealand + New Caledonian monophylum. The only phylogenetic hypothesis that satisfies both criteria (and is equally parsimonious with the 5 others and thus equally plausible) is the one presented in the figure 18.

Many features that are seen in the figure 18 agree well with the hypotheses of Popov & Shcherbakov (1996) and Burckhardt (2009). For instance, Australian, New Zealand and South American species form three monophyla (except for the genus *Peloridium* that is not included in the South American clade and is discussed below). The New Zealand clade is characterized by 4 apomorphies, the most interesting (and the only one non-homoplasious) of those being the form of the first abdominal

[29] Although they are known from other Cicadomorpha species described in literature, e.g. in some Aphrophoridae, a family closely related to Cercopidae where *Cercopis sanguinolenta* belongs to.

tergite: it is short and thick in *Oiophysa, Xenophyes* and *Xenophysella* and long and narrow in all other Peloridiidae. This character seems to correlate with the pulse frequency of acoustic signals (s. Discussion, section 4.3.). No New Caledonian representatives were included in the present study and thus it cannot be said if the monophyletic New Zealand clade would collapse to a paraphylum as in Popov & Shcherbakov (1996) and Burckhardt (2009), if any *Oiophysella* species would have been added.

The Australian monophylum is characterized by a single (homoplasious) apomorphy: character 78 (integumental glands absent from abdominal tergites). The South American clade (without *Peloridium*) by two apomorphic character states (both homoplasious): of character 29 (scales on flagellar petioles slender, weak and not touching each other) and of character 72 (orifice of the integumental gland sunk-in).

The South American (without *Peloridium*) and Australian clades are sister groups supported by 4 apomorphies, two of them non-homoplasious: asymmetrical tibial spurs and mandibular stylets not twisted. The New Zealand clade is sister to the monophylum that they form together; this whole grouping is supported by a single homoplasious synapomorphy, the presence of scale-like acanthae in the ventral tegminal sculpture.

Within the South American monophylum, *Peloridora* and *Idophysa* form a monophylum with *P. darwini* as the sister group – one more result in common with the study of Burckhardt (2009). The basal branching of *Xenophysella* within the New Zealand clade agrees well with data of biogeography: *Xenophysella* occurs only in the extreme South of New Zealand (Stewart Island, Fiordland and West Coast provinces of the South Island), making the branching sequence plausible when compared with the partitioning of Gondwana (Crook, 1981). The relationships within the Australian clade are not so clear in the present study, although the genus *Hackeriella* is also recovered as the monophylum with most derived character states (in contrast to the results of Popov & Shcherbakov, 1996, but in accordance with Burckhardt, 2009).

The most striking difference of the present results from phylogenetic hypotheses of both Popov & Shcherbakov (1996) and Burckhardt (2009) is the basalmost branching of the genus *Peloridium*. In both cited articles this genus was nested within the South American clade, even if branching off in it most basally in the study of Popov & Shcherbakov (1996). The position of *Peloridium* was the same in all 6 most parsimonious trees (fig. 10). Despite of the contradiction to the both cited studies, this result is consistent with the view of Evans (1982) who considered *Peloridium* the most basal (he did not use cladistic terminology very carefully) taxon in the family and *Peloridium*-like animals as ancestors for clades in Australia, New Zealand and South America. This position corresponds with some other characters, so is *Peloridium* the only genus that retains ocelli and also has macropterous representatives (that are admittedly rare) that posses not only tegmina but also hind wings and are supposed to be capable of flight (China, 1962). However, it must be kept in mind that the only apomorphy in the present study that supports the grouping of all not-*Peloridium* species together is the homoplasiuous character 59 that was mentioned above: the clade of all moss bugs except *Peloridium* possesses scale-like acanthae as sculptural elements on tegmina – but this character is absent from *Peloridora holdgatei* and *Idophysa chonos*. Thus, a more exhaustive test with a more extensive character matrix is needed to test the basal branching of *Peloridium.*

Another difference to the study of Burckhardt (2009) is the inner grouping of *Oiophysa* species. The sampling of the present study was poorer than his, but the closer association between *O. cumberi* of the North Island of New Zealand and *O. ablusa* from the extreme North of the South Island looks more plausible than *O. ablusa* grouping in Burckhardt (2009) with *O. paradoxa* that was found until now only on Stewart island at the extreme South of the New Zealand archipelago and is most likely limited to it.

Hemiodoecus from Australia was paraphyletic in the present analysis, also in contradiction to Burckhardt (2009). The strict consensus tree (fig. 11) could not resolve the relations of *Hemiodoecus* at all, putting its species together with *Hemiodoecellus* and *Hemiowoodwardia*. An analysis with a more exhaustive character matrix is needed to clarify this matter, but it is worth mentioning that e.g. confusing host plant specificities in *Hemiodoecus leai* also left some doubts on the consistency of this species (s. Discussion, section 4.1.), which might influence a phylogenetic analysis of the genus.

4.5 Integrative evaluation of the established phylogenetic hypothesis with data on bioacoustics, ecology, cytogenetics and symbiont biology

The taxon sampling in study of bacterial endosymbionts in Peloridiidae published by Küchler et al. (2013) is somewhat poorer than that of the present study, particularly South American taxa were underrepresented (fig. 19). Still, the comparison of their results with the phylogenetic hypothesis from section 4.4. is quite informative. Striking similarities are for instance the monophyly of the Australian clade in symbiotic bacteria and in fig. 18. However, in the Peloridiidae phylogeny of Küchler et al. (2013) – fig. 19, right side – the Australian clade is not monophyletic due to the outlier *Hemiodoecellus fidelis* that groups with the South American *Peloridium hammoniorum*. A highly interesting feature is the basal branching of *P. hammoniorum* in both symbiont and host tree of Küchler et al. (2013), which corresponds well to the results of the present study (fig. 10). Another interesting result is non-monophyly of the Australian genus *Hemiodoecus* in the Peloridiidae phylogeny of Küchler et al. (2013). The genus is also not monophyletic in the phylogenetic hypothesis based on fine morphology (fig. 18) and host plant affinities of *Hemiodoecus leai* have already been mentioned as casting doubt on the consistency of the genus. Morphological features of the genus and its species might be worth a review and more molecular markers need to be applied for testing the monophyly of *Hemiodoecus*.

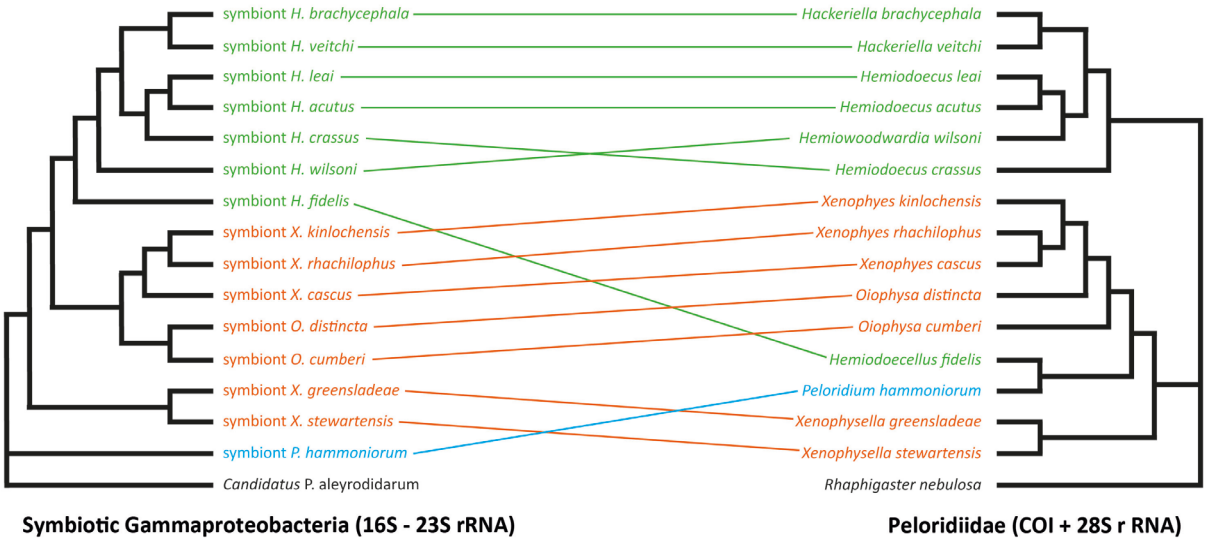

Figure 19. Molecular phylogeny of bacterial symbionts and their peloridiid hosts, after Küchler et al., 2013. Australian species are in green, South American species in blue, New Zealand species in ochre red. Symbionts are connected by coloured lines with their respective hosts.

Results of Küchler et al. (2013) and Santos-Garcia et al. (2014) indicate that bacterial endosymbionts of Peloridiidae are most closely related to the symbionts of Aleyrodidae and Psyllidae (both Sternorrhyncha). This is barely an indication of a possible sister-group relationship between Peloridiidae and Sternorrhyncha (or any of their subgroups), since some features of the genome of the endosymbiont *Evansia* make an inheritance from the ancestral species of all Hemiptera unlikely, along with the fact that in many other Hemiptera lineages this ancestral *Evansia*-like bacteria must have gone extinct and replaced by other symbionts (Santos-Garcia et al., 2014). It seems that in Hemiptera all endosymbiont acquisitions are not too ancient (Bennett & Moran, 2015) and a relatively recent horizontal transfer event e.g. from some Sternorrhyncha to Peloridiidae would make much sense, but makes any sister group inference for Peloridiidae here not very plausible.

Grozeva et al. (2014) and Kuznetsova et al. (2015) published two accounts on cytogenetics of Peloridiidae, a matter not studied till then. The New Zealand *Xenophyes cascus* posses the chromosomal complement of 26A + X(0), and the South American *Peloridium pomponorum* – 30A + X(0). Thus, both species share the X(0) sex determination system with basal Heteroptera and the majority of Sterno- and Auchenorrhyncha – this must be considered a symplesiomorphy that is not capable of providing clues on the sister-group relationships of Peloridiidae, only on the fact that the XY-system probably only became established in more advanced heteropteran groups (Ueshima, 1979). The same is true concerning the telomeric TTAGG-sequence that is widespread in Hemiptera as in Insecta in general, and only seems to disappear in the higher branches of Heteroptera tree (Kuznetsova et al., 2015). However, the cytogenetic studies did deliver one strong clue on the sister-group relationship of Peloridiidae. *Peloridium pomponorum* was found by Kuznetsova et al. (2015) to share the sex chromosome post-reduction (fig. 20) with Heteroptera. This feature is uniqe and is a strong potential synapomorphy for Heteropterodea. It is, however, in conflict with the results of phylogenetic analysis based on fine morphology presented in the previous chapter, where the sister group relationship between Peloridiidae and Auchenorrhyncha received the strongest support. The conflict of the two hypotheses, Heteropterodea vs. Peloridiidae + Auchenorrhyncha, is not completely

resolved by other studies as well, with some supporting Heteropterodea (Schlee, 1969; D'Urso, 1993; Li et al, 2017) and some its alternative (Misof et al., 2014; Wang et al., 2015; Yoshizawa et al., 2017). An analysis with richer taxa and character sampling is needed to shed more light on this difficult matter. What can be stated with certainty is that the degree of homoplasy and parallel developments in the evolution of Hemiptera must have been extensive.

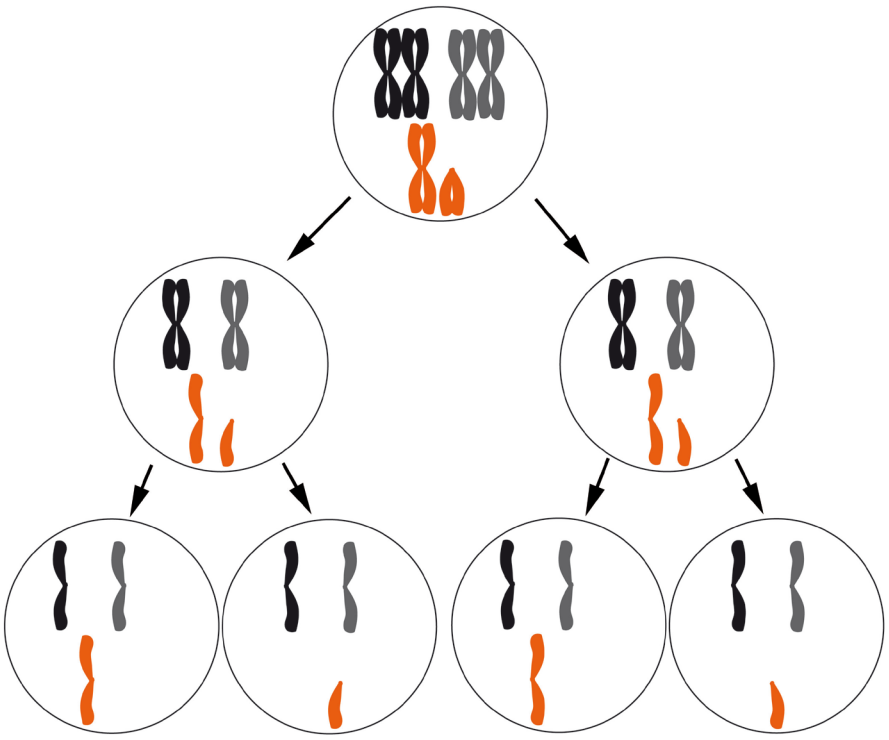

Figure 20. A schema of meiotic sex chromosome post-reduction. The first meiotic division is reductional for autosomes (black and grey), but equational for sex chromosomes, whereas the second division is vice versa.

When the bioacoustic traits described in the Results section 3.6. are compared with the phylogenetic hypothesis provided by SEM characters, some conclusions can be made. For instance, both *Oiophysa cumberi* and *Xenophyes cascus* share the traits of having various types of echemes in their repertoire, and using higher pulse frequencies (19-62 Hz) – as compared to the *Peloridium hammoniorum* and *P. pomponorum* (single echeme type, up to 4 Hz pulse frequency) that branch off most basally in Peloridiidae, or *Hackeriella veitchi* (single echeme type, up to 8 Hz) that belongs to the species of the family with most derived character states (fig. 18). Since both *O. cumberi* and *X. cascus* belong to the New Zealand clade, the traits of their signals mentioned above could be autapomorphic for the New Zealand clade. However, nothing can be stated here with certainty until bioacoustics of the third New Zealand genus *Xenophysella* is studied.

Both *H. veitchi* and *P. hammoniorum* demonstrated a peculiar behavior in mating and signalling context: males were often riding on the backs of their conspecifics of both sexes. This behavior, however, was only once observed in *X. cascus* and never in *O. cumberi* or *Xenophysella stewartensis*. Due to the aforementioned position of *H. veitchi* and *P. hammoniorum* in the phylogeny of Peloridiidae, this could mean that the riding behavior is plesiomorphic within the family and its absence in New Zealand clade another apomorphy of this subgroup. Cobben (1978, p. 200)

mentiones similar behaviour in Nepomorpha and Cimicomorpha:Reduviidae (both Heteroptera), where males ride on the backs of females before mating. “The male [of *Rhinocoris*] is apparently unable to distinguish the sex of another individual until it has assumed the riding position on it” and probably uses his labial sensilla for this, suggests Cobben. If this behaviour in Peloridiidae has the same putative function of using labial receptors to recognize potential sexual partners, then some correlations could be expected in the structure of the receptors between the species that demonstrate similar behaviour. However, the present study did not reveal any external morphological similarities, but the internal structures (such as innervations of particular labial sensilla and their physiological responses) are worth studying.

Acoustic traits are very hard to apply in phylogenetic inference, since signals of even closely related species can be very different, and homologisation of particular features of the calls is extremely complicated and unreliable (Claridge, 2005; Tishechkin, 2005). However, there is an indication in the present study that could allow postulation of homology of the bioacoustics traits as pulse frequency or echeme diversity between different Peloridiidae species: the correlation between bioacoustics parameters and morphology of the first abdominal tergite that is presumably involved in the signal production (Discussion, section 4.3.). If the character matrix (Results section 3.4., characters with an asterisk at the end of the list) is supplemented with three characters: pulse frequency low/high, echeme type single/more than one and male riding behavior uncommon/common – the result is worth considering. Some character states on acoustic traits in outgroups could be supplemented from literature. Gogala (1984) mentions that *Corythucha ciliata* produced “ticking” signals by lateral jerking of the abdomen; since no other signals were reported, a single echeme type was postulated; the pulse frequency was estimated from fig. 2 (Gogala, 1984) as high (36 Hz). Tishechkin (2016) reports signals of *Laodelphax striatella*, with high pulse frequency and several echeme types in repertoire. Tishechkin (2003) provides oscillograms of calls of *Cercopis vulnerata* and *C. intermedia*; in both species the pulse frequency is high and various types of echemes are present and it was hypothesized that *Cercopis sanguinolenta* would have the same character states. Benediktov (2007) not only reports on tremulation in *Pyrrhocoris apterus* (single echeme type, pulse frequencies estimated from Benediktov, 2007, fig. 1. as being around 10 Hz), he also describes representatives of this species mounting each other. All other in- and outgroup taxa were coded with “?” (= missing character state).

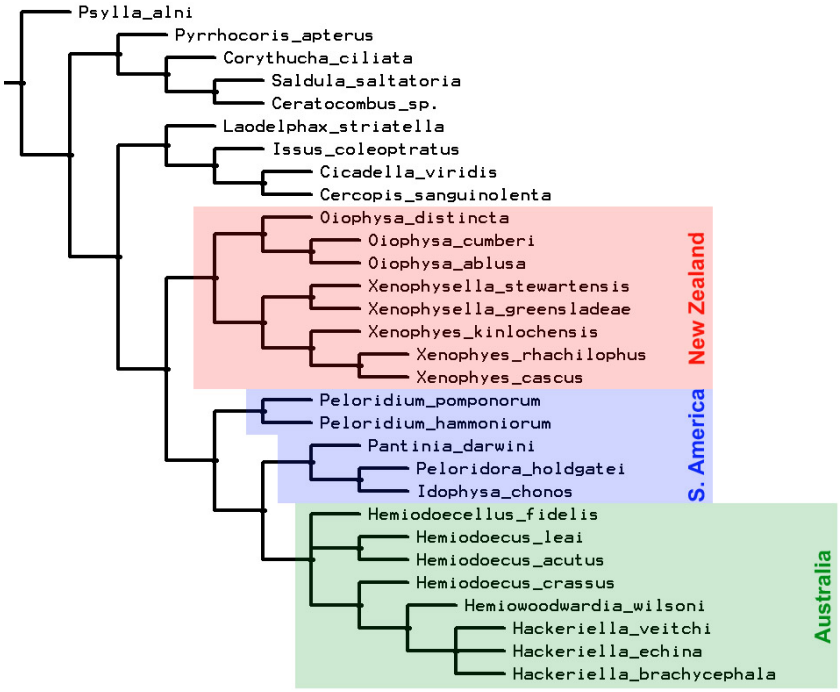

Figure 21. The phylogenetic hypothesis on Peloridiidae relationships, including the three behavioural/acoustic characters. Majority rule consensus of 13 most parsimonious trees.

The analysis of the matrix complemented this way delivered 13 most parsimonious trees. A strict consensus between them put all Peloridiidae together with Auchenorrhyncha into one largely unresolved clade, but the majority rule consensus tree (fig. 21.) provided a hypothesis very similar to that presented by Burckhardt (2009). The South American clade is not monophyletic, but *Peloridium* is now very close to the rest of the species from that biogeographic region, and the New Zealand clade branches off most basally. This hypothesis has quite poor statistical support and a lot of missing character states and cannot be preferred to the one presented in the previous chapter (fig. 18). Still, it illustrates the potential value of behavioral and bioacoustic characters for phylogenetic inference and underlines the necessity to study this and other aspects of Peloridiidae life that can bring us closer to a system of living organisms and not dry (or alcohol-stored) museum specimens.

4.6 Major conclusions and perspectives

The most important results of the present study can be summarized in the following points:

1. Peloridiidae are proven to feed on bryophytes, mosses and liverworts alike. As a family, they do not show preferences for particular taxa of bryophytes, even if some of its species may, so no phylogenetic cues are provided by host plant associations. The factor influencing peloridiid host preferences more than taxonomy is probably the moisture regime that can be provided by the plant and/or climate of the location. Therefore, when collecting in the new

locality, bryophytes of the families Dicranaceae, Hypopterygiaceae, Sphagnaceae and Polytrichaceae should be analyzed first, since they seem to be the best providers of the environmental conditions favourable for Peloridiidae.

2. Peloridiidae are confirmed as a monophyletic grouping in the phylogenetic analysis based on traits of fine morphology. The Australian species form a monophylum as well, with a monophylum embracing all studied South American species (except *Peloridium*) as the sister group. The monophyletic New Zealand clade is the sister to the monophylum built by them. The genus *Peloridium* branches off most basally in the family. Most results correspond well with previously published phylogenetic hypotheses. However, the statistical support for different nodes is not very high and homoplasy level relatively high.

3. Morphological evidence for the sister-group relationship between Peloridiidae and Auchenorrhyncha is presented and this grouping has the best statistical support among all the nodes in the phylogenetic analysis. However, possible apomorphies of the clade are not unquestionable and other characters, such as sex chromosome post-reduction, strongly support the grouping of Peloridiidae with Heteroptera (Heteropterodea), along with other literature data. Clearly more research is needed on this matter.

4. The position of the genus *Peloridium* and of the New Zealand clade changed when acoustic and behavioural traits were included in the phylogenetic analysis. This result is more a mind game than a serious phylogenetic hypothesis, since vibrational calls and behavior were studied in a very limited sample of species and the homologisation of such traits is problematic. Still, it illustrates the potential of integrative methods, underlines the need of a deeper study of Peloridiidae communication and behavior and invites to implementation of integrative approaches in systematics.

The outlook into research projects (some of which are already ongoing) on Peloridiidae that are based on the results of the following study:

1. An analysis of climatic factors and morphological features of bryophytes correlating with occurrence of Peloridiidae (Hartung, Kürschner & Brown, in preparation)

2. A detailed analysis of vibrational signals of Peloridiidae, their different contexts and types, individual variation and taxonomic potential

3. A more extensive study on a larger sample of Hemiptera species and outgroups with methods of scanning electron miscrocopy, to enlarge the existing character matrix and produce a more robust phylogenetic hypothesis

4. A µCT study of brachypterous and macropterous specimens of *Peloridium hammoniorum*, *P. pomponorum* and *Xenophyes cascus,* with special consideration of possible flight musculature and tymbal apparatus; in cooperation with Kristin Mahlow (Museum of Natural History, Berlin) and Leonidas-Romanos Davranoglou (Oxford University)

5 Summary / Zusammenfassung

5.1 Summary

Some insufficiently studied aspects of Peloridiidae biology, such as behaviour, intraspecific communication, host plant preferences and fine morphology were investigated. The newly acquired information was used for production of a phylogenetic hypothesis on Peloridiidae relationships and critical evaluation of the existing ones.

Host plants of Peloridiidae were studied systematically in Australia, Chile and New Zealand. Literature records on host plant associations in Peloridiidae were critically evaluated and significantly enriched: to the 11 different host plant records in literature, 40 moss species and 20 liverwort species were added. Peloridiidae as taxon were found not to be bound on any particular bryophyte taxa, although they regularly occured in species of Dicranaceae, Hypopterygiaceae, Polytrichaceae and Sphagnaceae in all three biogeographic regions that were sampled. Different species and genera can differ in their host plant specificity: *Peloridium* occurred almost exclusively in *Sphagnum* or *Polytrichadelphus, Oiophysa distincta* only on *Dendrohypopterygium filiculiforme*, whereas representatives of the genus *Xenophyes* seemed to inhabit almost every species growing in sufficient amounts.

Vibrational signals of several Peloridiidae species are presented for the first time: *Xenophyes cascus, Oiophysa cumberi* (both New Zealand), *Peloridium hammoniorum* and *P. pomponorum* (both South America). Some features of these signals (echeme diversity, echeme duration, pulse frequency, dominant fundamental frequencies) were compared with the respective traits in previously analyzed species *Hackeriella veitchi* (Australia) and involved in discussion of phylogenetic relationships of the family. The two New Zealand species were similar in their use of higher pulse frequencies and variable echeme types, whereas the both South American species and *H. veitchi* had lower frequencies and only one echeme type.

Detailed information on fine morphology of antennae, genae, labium tip, tegminal sculpture, tarsi, abdominal sculpture and integumental glands in 21 Peloridiidae species is presented for the first time. Respective characters were also studied in the outgroup taxa; in many cases, this morphological information is also new to science. The findings are formalized as a matrix of 93 characters and analyzed with methods of maximum parsimony. A monophyletic Peloridiidae results, with a strong support of the sister-group relationship with Auchenorrhyncha. However, the characters supporting this group are not unambiguous and literature data speak more in favour of the grouping of Peloridiidae with Heteroptera. Another strong support for Heteropterodea comes from a cytogenetic study, uncovering sex chromosome post-reduction only in Heteroptera and Peloridiidae, but not in Auchenorrhyncha.

The intrafamiliar structure of Peloridiidae according to the established phylogenetic hypothesis is similar to the ones known from literature, uncovering monophyletic New Zealand and Australian clades, the Australian being most closely related to a monophylum built by South American species minus *Peloridium*. The New Zealand clade is sister to the monophylum built by Australian + South American species. Genus *Peloridium* branches off most basally, which contradicts both published cladistic analyses of the family, but is well in concert with data on symbiont biology. If three

additional characters (two acoustic and one behavioral) are included in the matrix, the phylogenetic hypothesis loses on statistic corroboration, but the genus *Peloridium* moves much closer to other South American species, the New Zealand clade branching off most basally, which coincides best with the previously published phylogenetic hypotheses. However, this result is problematic due to highly complicated homologization of bioacoustic traits among different taxa.

5.2 Zusammenfassung

Einige wenig bekannte Aspekte der Biologie der Peloridiidae, wie Verhalten, intraspezifische Kommunikation, Wirtspflanzenassoziationen und Feinmorphologie wurden untersucht. Die gewonnenen Informationen wurden benutzt, um eine phylogenetische Hypothese zu den intrafamiliären Verhältnissen bei den Peloridiidae und ihrer möglichen Außengruppe aufzustellen.

Wirtspflanzen der Peloridiidae wurden in Australien, Chile und Neuseeland systematicsh besammelt. Literaturangaben zu Wirtspflanzenassoziationen in der Familie konnten kritisch überprüft und signifikant bereichert werden: zu den 11 in Literatur beschriebenen Bryophyten kamen 40 zusätzliche Moos- und 20 Lebermoosarten. Peloridiidae als Familie scheinen keine taxonomische Präferenz für ein bestimmtes Taxon der Bryophyta zu haben, obwohl sie etwa auf Arten aus den Familien Dicranaceae, Hypopterygiaceae, Polytrichaceae und Sphagnaceae in allen drei biogeographischen Regionen vorkamen. Unterschiedliche Arten und Gattungen der Peloridiidae können sich in ihrer Selektivität bei Wirtspflanzenwahl unterscheiden: *Peloridium* wurde fast ausschließlich auf *Sphagnum* oder *Polytrichadelphus* gefunden*, Oiophysa distincta* nur auf *Dendrohypopterygium filiculiforme*, während Vertreter der Gattung *Xenophyes* fast jede Bryophytenart zu bewohnen schienen, die in ausreichender Menge vorhanden war.

Vibrationssignale mehrerer Arten der Peloridiidae wurden zu ersten Mal aufgenommen und ausgewertet: *Xenophyes cascus, Oiophysa cumberi* (beide aus Neuseeland), *Peloridium hammoniorum* und *P. pomponorum* (beide aus Südamerika). Einige Eigenschaften dieser Signale (Diversität der Silben, Länge der Silben, Pulsfrequenz, Grundfrequenz) wurden verglichen mit den vorher schon bekannten Gesängen der australischen Art *Hackeriella veitchi* und in der Diskussion der Verwandtschaftsbeziegungen der Peloridiidae benutzt. Die beiden Arten aus Neuseeland waren einander ähnlich in hoher Pulsfrequenz und Diversität der Silbentypen, wobei die beiden Arten aus Südamerika und die *H. veitchi* niedrigere Pulsfrequenzen benutzten und nur ein Typ von Silbe aufwiesen.

Detaillierte Informationen zu feinen morphologischen Merkmalen der Antennen, Genae, Labiumspitze, Skulptur der Tegmina, Tarsen, Skulptur des Abdomens und Integumentaldrüsen in 21 Arten der Peloridiidae wurden zum ersten Mal präsentiert. Die entsprechenden Merkmale wurden auch in den Außengruppentaxa untersucht; in vielen Fällen wurden hier der Wissenschaft bislang unbekannte Informationen gewonnen. Die Ergebnisse wurden in der Form einer Merkmalsmatrix von 93 Merkmalen zusammengefasst und mit Methoden der maximum parsimony untersucht. Die Peloridiidae in der Analyse erwiesen sich als ein Monophylum, mit einer beträchtlichen statistischen Unterstützung für ein Schwestergruppenverhältnis mit den Auchenorrhyncha. Die Merkmale, die dieses Verhältnis unterstützen, sind aber nicht unumstritten, und Literaturdaten neigen mehr zur

Unterstützung einer Gruppierung der Peloridiidae mit den Heteroptera als Schwestergruppe (Heteropterodea). Weitere Unterstützung für Heteropterodea kommt aus den Daten der Zytogenetik: nur Vertreter der Peloridiidae und Heteroptera weisen meiotische Postreduktion der Geschlechtschromosomen auf, die von keinem Vertreter der Auchenorrhyncha bekannt ist.

Die intrafamiliären Verhältnisse der Peloridiidae sind nach der erarbeiteten phylogenetischen Hypothese den aus Literatur bekannten ziemlich ähnlich, indem sie zum Beispiel monophyletische Kladen für jeweils australische oder neuseeländische Vertreter etablieren. Die australische Klade ist am nächsten verwandt mit einem Monophylum gebildet aus allen südamerikanischen Arten (außer der Gattung *Peloridium*). Die neuseeländische Klade ist die Schwestergruppe zu der Klade aus australischen und diesen südamerikanischen Arten. Die Gattung *Peloridium* ist die Schwestergruppe zu allen anderen Peloridiidae, was den beiden aus Literatur bekannten phylogenetischen Hypothesen widerspricht, aber gut mit Daten aus Symbiontenbiologie übereinstimmt. Wenn man 3 weitere Merkmale in die phylogenetische Analyse mit einnimmt, zwei akustische und ein Verhaltensmerkmal, dann verliert die phylogenetische Hypothese zwar an statistischer Robustheit, aber die Gattung *Peloridium* wird in die Nähe anderer südamerikanischen Vertreter gerückt und die Neuseeland-Klade wird zur Schwestergruppe aller weiteren Peloridiidae, was viel besser mit den aus der Literatur bekannten phylogenetischen Hypothesen übereinstimmt. Dieses Ergebnis ist jedoch mit größter Vorsicht zu diskutieren, wegen der großer Unsicherheit bei der Homologisierung von bioakustischen Merkmalen zwischen den unterschiedlichen Taxa.

6 Acknowledgments

It has been a long quest, and many people helped to fulfil it.

First of all, I would like to thank Hannelore Hoch for making it possible. Supervising a candidate who set off to change the world and (inevitably) ended in cautiously suggesting a possible method that would probably bring about a slight modification of the world at some uncertain point in the future is not a task for a faint of heart. Still, on the way I learned more than I could possibly tell here – and this is the goal of a study, after all.

Second, I am deeply grateful to the Elsa Neumann doctoral grant program (application number H49023) and the travel grant of German Academic Exchange (DAAD) (processing number D/09/04219) for the financial support. The collecting trip to Australia and New Zealand, along with many other things, would haven been impossible without it, and the study itself would have been impossible without the collecting trip, along with those many other things.

I'd like to thank all the environment protection officers who were very helpful with collection and export permits, especially Jacqui Brock (Environment Protection Agency, Queensland, Australia), Julie McInnes (Department of Environment, Climate Change & Water, New South Wales, Australia), Christo Haselden (Lord Howe Island Board, Australia – even if I never made it there), Linda Tucker (Department of Sustainability and Environment, Victoria, Australia), Stewart Blackhall, Michael Driessen and Naomi Lawrence (all Department of Primary Industries, Parks, Water and Environment, Tasmania, Australia), Michael Easton (Wellington Park Management Trust, Tasmania, Australia), Glenda Jones (federal Department of the Environment, Water, Heritage and the Arts, Canberra, Australia) and Jeanine Bishop (Department Of Conservation, New Zealand). Rangers and officials in the field were of most invaluable help, among others: Kenneth Green, Sue Lewis and Susanna Venn from the Snowy Region Visitor Center in Jindabyne, NSW, Australia (thanks for the microscope and the walkie-talkie!), Sylvia van der Peet from Apollo Bay, West Otway Parks Victoria, Australia (thanks for your effort!). Most special thanks go to the rangers and officers of the New England National Park in NSW, Australia, who not only provided me with a microscope, but also let me stay for two weeks at their a little dusty, but very tranquil and charismatic research station for absolutely no fee; unfortunately, the names of the people have been lost with an old phone card, but I do cherish most warm memories of their hospitality.

I am happy to have met several colleagues whose expertise in Peloridiidae (and Hemiptera in general) made this thesis possible at all. Geoff Monteith (Queensland Museum, Brisbane) introduced me into the art and science of collecting the Peloridiidae, helped immensly with collecting gear, useful advice and materials and was a most gracious host. I am also indebted to his colleagues at the Museum, Geoff Thompson in the first place. George Gibbs (Victoria University, Wellington) showed me in New Zealand some perfect places to collect moss bugs – not to mention several occasions on which he later supplied me with living specimens of Peloridiidae that were invaluable for acoustic recordings, cytogenetics and research on bacterial symbionts; George's hospitality is also legendary. Jakob Damgaard provided a lot of useful practical advice and was an encouraging discussion partner, even though we haven't met in person yet (but I do hope we will some day). Marie-Claude Larivière

(Arthropod Collection, Auckland) provided me with some really essential materials and discussing peloridiid affairs with her was an inspiration (good luck to you!). Daniel Burckhardt (Naturhistorisches Museum, Basel) provided scientific guidance and friendly help at the time when it was needed most. Roland Mühlethaler (then Natural History Museum, Berlin) was the first person in the world who found a proper way to record the calls of Peloridiidae with a vibrometer and kindly taught me how to do this. Roman Rakitov (Paleontological Institute, Moscow) helped collecting during the Chilean trip, was a good travel companion and made me look on some of the aspects of the peloridiid life differently.

You cannot study moss bugs without studying mosses, and this thesis profited immensely from cooperation and assistance of many bryologists. Elizabeth Brown, then a curator at the National Herbarium in Sydney, took the immense job of identifying the voucher samples I collected in Australia, supplied me with best literature, best alcohol (for collecting!) and most valuable advice. I am very sorry she does not live anymore to see this thesis completed and accept my gratitude. Harald Kürschner (Free University, Berlin) dedicated a lot of his time and effort to control my identifications of bryophytes from Chile and New Zealand, was an inspiring and pleasant discussion partner; I am looking forward to publish with him an account on morphological traits of bryophytes favouring the occurrence of Peloridiidae. Pina Milne (Royal Botanic Gardens, Melbourne) and David Meagher (University of Melbourne) were very eager to help with their knowledge, collecting gear and materials. David went even further and helped me out of a dire situation when I was stranded with just a handful of dollars in my pocket and still 2000 more miles to make. I do hope one day I have a chance to return his favour.

I am deeply obliged to all the colleagues at the Karlsruhe State Museum of Natural History, who had complete understanding for my studies during my time as an assistant at SMNK, supported me wherever they could and were always eager to discuss hemipteran affairs that might appear insignificant for those who are used to think in holometabolan scales. Manfred Verhaagh was a most loyal group leader and his colleagues most helpful, especially Michael Falkenberg, Petra Guder, Wolfgang Hohner, Alexander Riedel and Robert Trusch.

I am very grateful to Volker Lohrmann (Übersee-Museum, Bremen) – for many things, but especially for not letting me forget what all that jazz is really about. If it was not for him, I might have given up in the middle.

A large number of people from various parts of the world helped with advice, a review, technical support, shared their knowledge, their photos, their thoughts, their results or their inspiration; the list is probably not complete, but the most prominent are: Manfred Asche, Martin Baehr, Petr Bañař, Thierry Bourgoin, Wenjun Bu, Daniel Burckhardt, Leonidas-Romanos Davranoglou, Jürgen Deckert, Chris Dietrich, Gabriele Drescher, Jens Burckhard Funk, Vladimir Gnezdilov, Matija Gogala, Snejana Grozeva, Hans Grube, Oliver Hampe, Werner Holzinger, Petr Kment, Stefan Küchler, Markus Kühbacher, Valentina Kuznetsova, Kristin Mahlow, Roland Mühlethaler, Alexei Polilov, Yuri Popov (may he rest in peace), Hossein Rajaei, David Redei, Heinrich Riesemeier, Anke Sänger, Diego Santos-Garcia, Gerhard Scholtz, Dmitry Shcherbakov, Evelina Siegle, Rico Spangenberg, Adam Stroiński, Pavel Štys, Jacek Szwedo, Mikhail Tyaglov, Manfred Uhlig, Klaus Voigt, Ekkehard Wachmannn, Gerd

Weidemann, Andreas Wessel, Michael Wilson, Benjamin Wipfler, Urs Wyss, Qiang Xie, Jutta Zeller and Mathias Zilch.

A thesis cannot be finished without formalities – I am deeply indebted to many people in this respect, but especially to Friederike Schwarz (Natural History Museum, Berlin) and Jana Lahmer (Humboldt University, Berlin). Without their most gracious support this work would not be a success.

Computers and programs are a part of the work, too – Michael Czura and Diane Raspe were of invaluable help whenever something did not function properly or yet another program had to be installed.

My partner Susanne Grube was a role model for me and always ready to share her love and understanding. She always gave me courage – and when necessary, also a kick. Thank you.

My parents, Nadezhda and Vladimir Hartung, helped immensely, always believing in me and supporting me – not only in words, but in deeds, and that through all my life. Thank you.

This work is dedicated to the memory of my grandfather Viktor Fjodorov. Growing up during the war, after his father perished in Gulag, he never had a chance for an education higher than an evening school – but encouraged the pursuit of knowledge in all his children and grandchildren and would be pleased to know that one of those would go as far as to write a doctoral thesis. He's not with us anymore, but his spirit still is. *Быть добру*!

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8 Plates

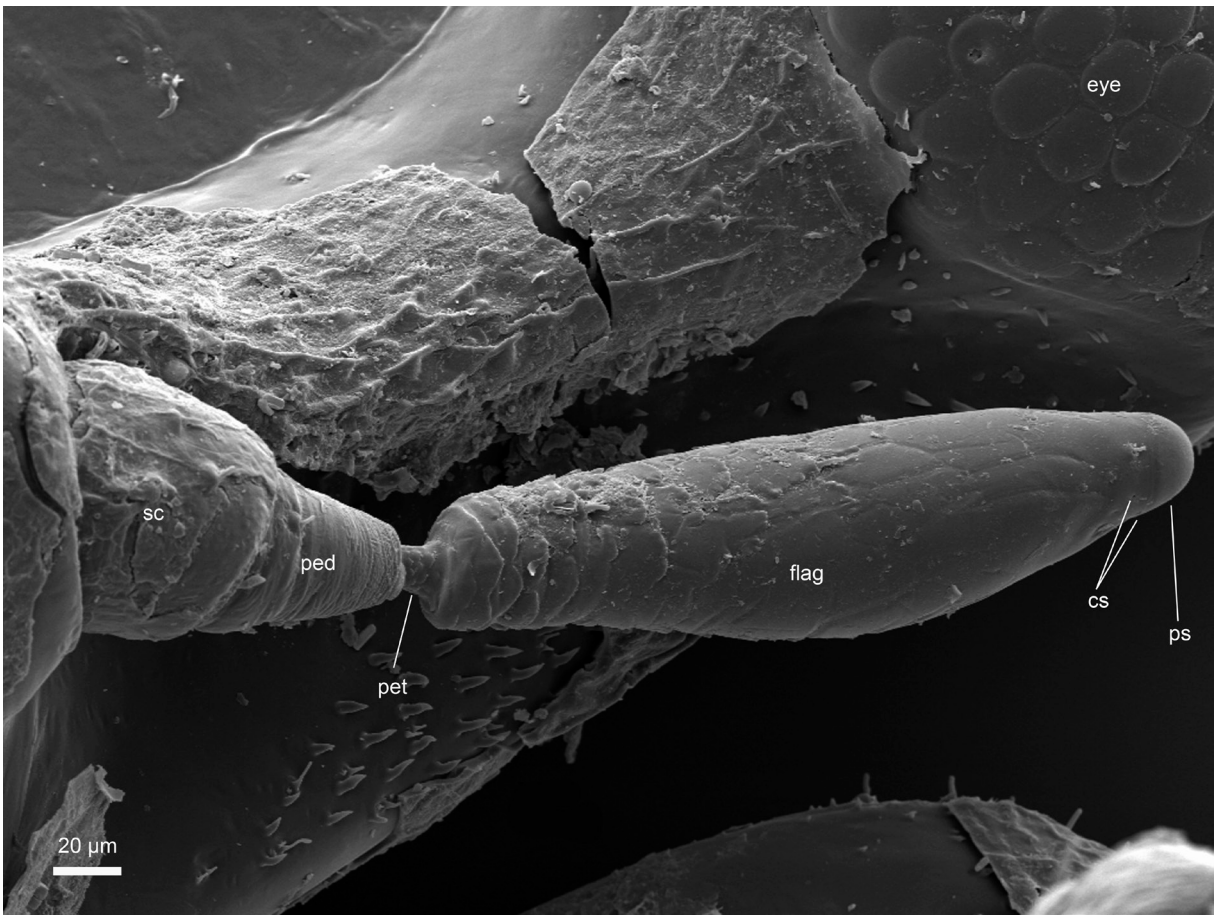


Plate fig. 1. Left antenna of *Hemiodoecus acutus*, ventral view. cs = coeloconic sensilla, eye = compound eye, flag = flagellum, ps = placoid sensillum, ped = pedicel, pet = petiolus of the flagellum, sc = scape.

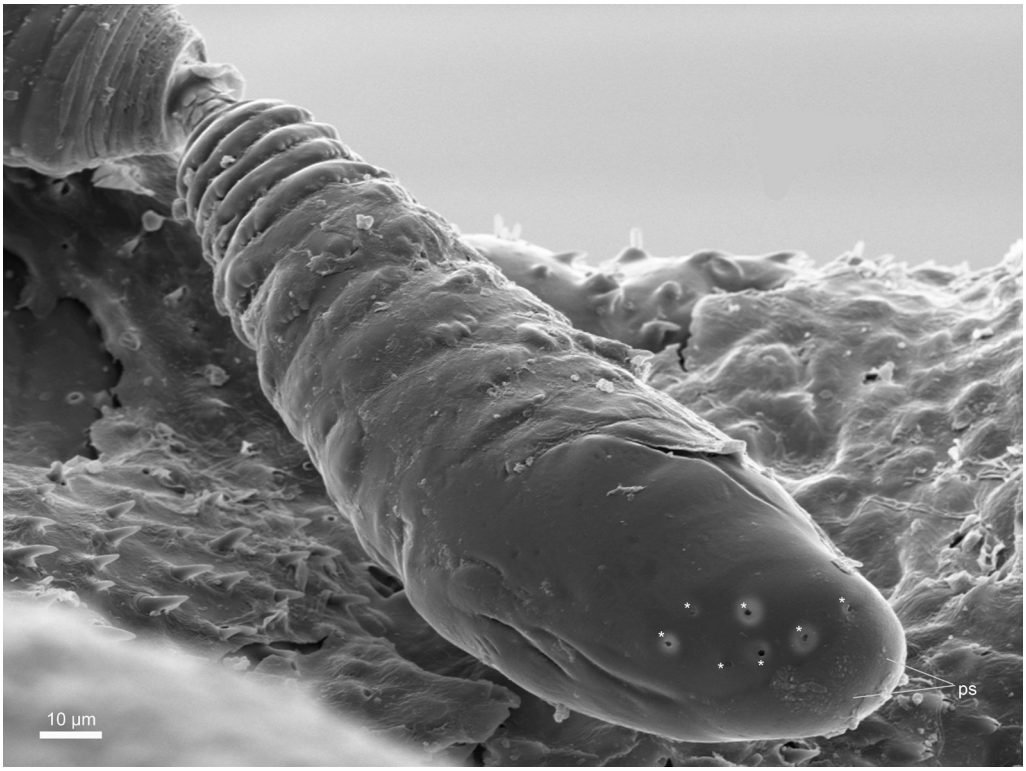


Plate fig. 2. Left antenna of *Oiophysa ablusa*, caudal view. Asterisks mark the coeloconic sensilla, ps = placoid sensillum.

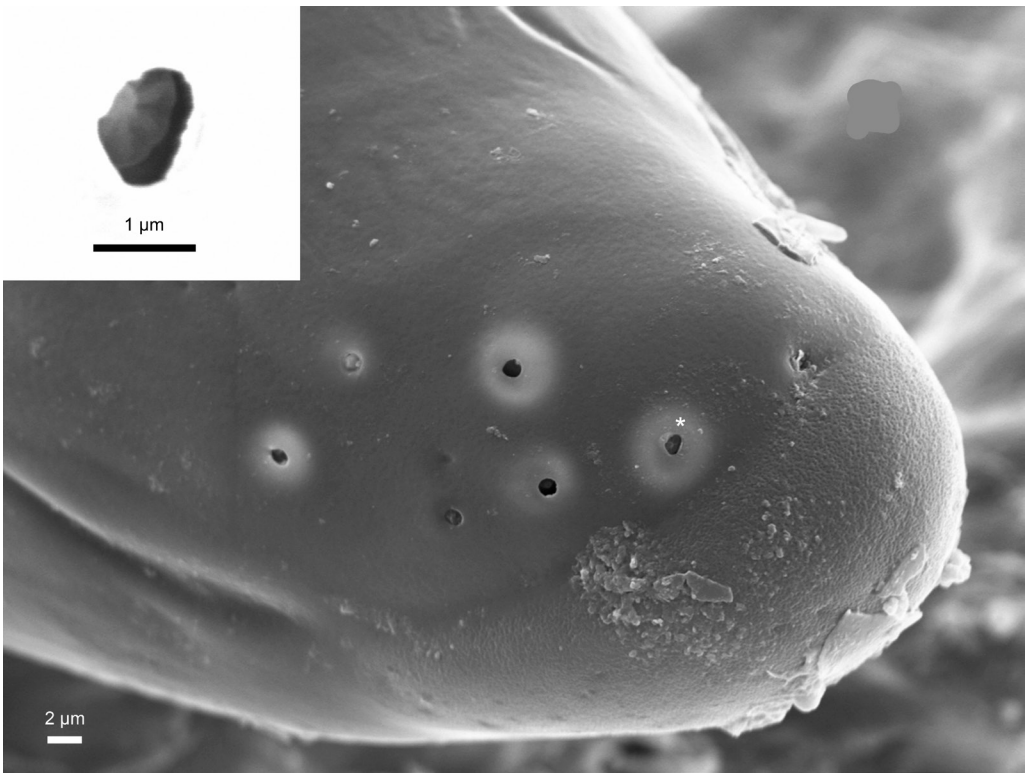


Plate fig. 3. Tip of the left antenna of *Oiophysa ablusa* from fig. 2, magnified. The fine pores of the placoid sensillum are clearly seen. The coeloconic sensillum marked with asterisk is shown magnified in the inlet (photographed with much higher contrast to recognize details of the inner structure).

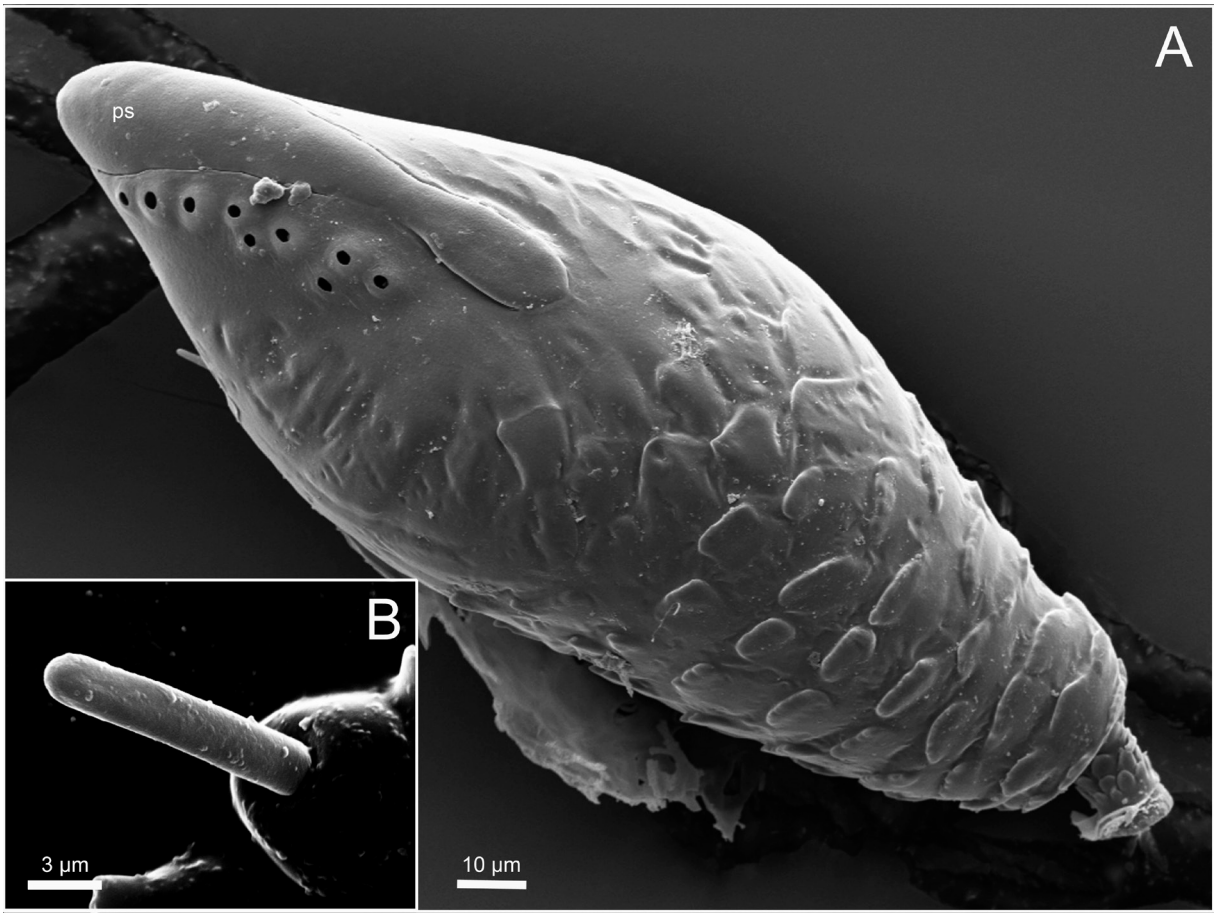


Plate fig. 4. A - left antennal flagellum of *Peloridium pomponorum*, separated from the rest of the body, dorsal view. ps = placoid sensillum; note the furrow that separates it from the rest of the flagellum. Coeloconic sensilla are well visible black pits. B – a trichoid sensillum of the flagellum of *Peloridium hammoniorum*.

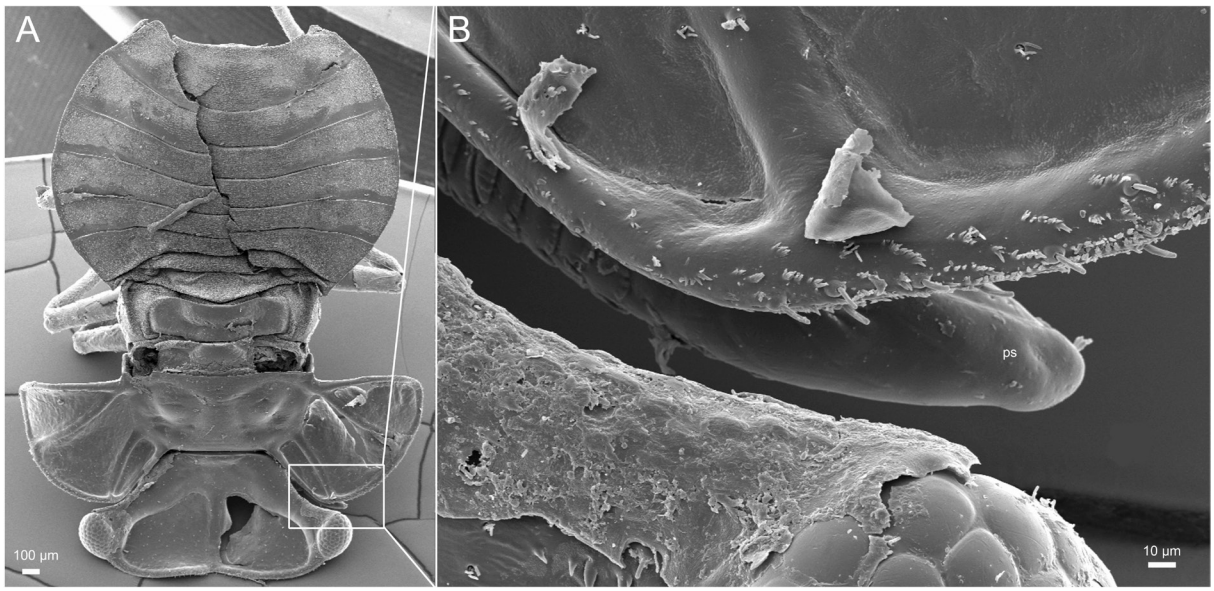


Plate fig. 5. A – *Pantinia darwini*, dorsal view; the white rectangle shows the area that is magnified in (B). B – left antenna of *P. darwini*, dorsal view; ps = placoid sensillum.

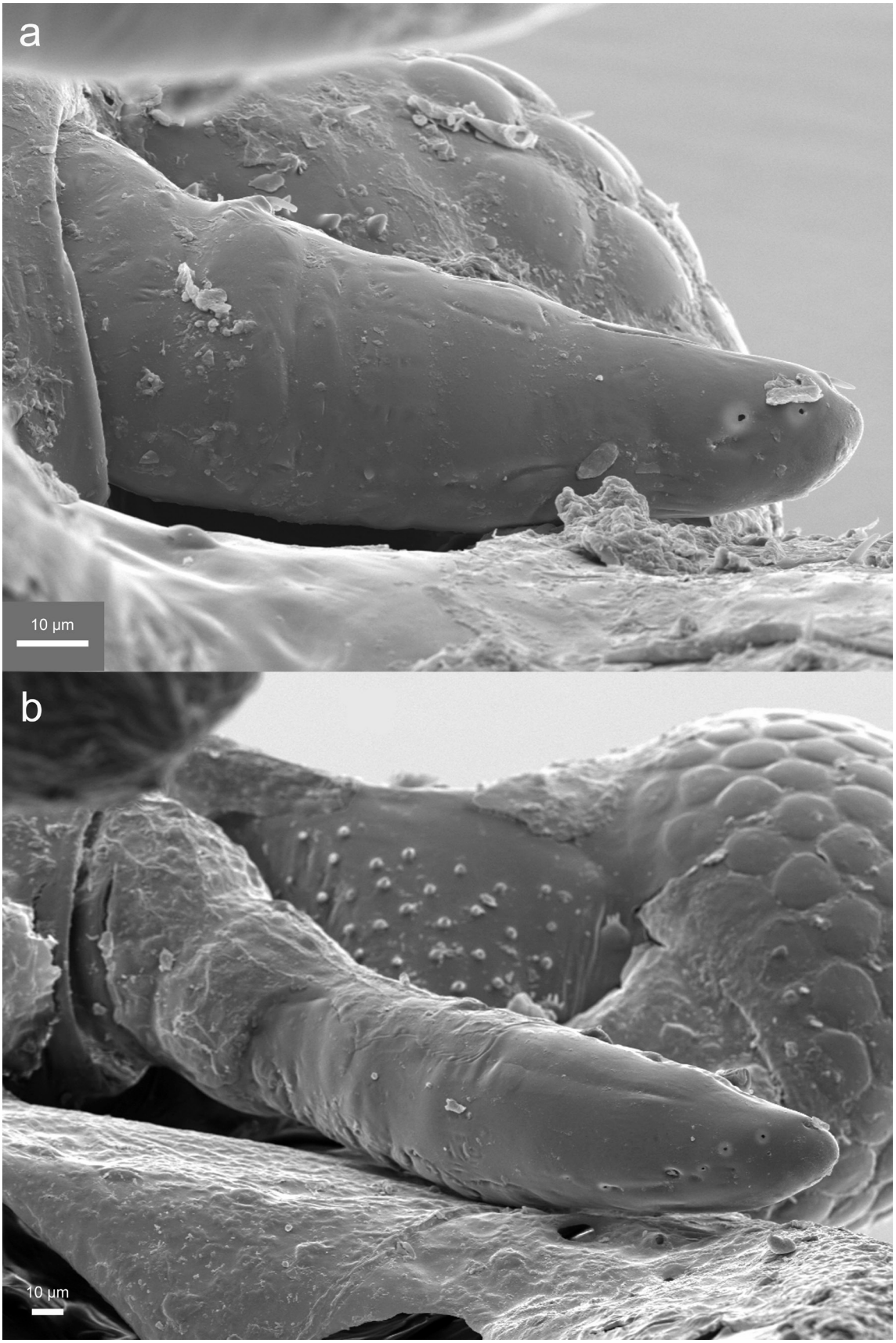


Plate fig. 6. Antennal flagellum in larvae of *Hackeriella brachycephala*. a – second instar, b – fifth instar.

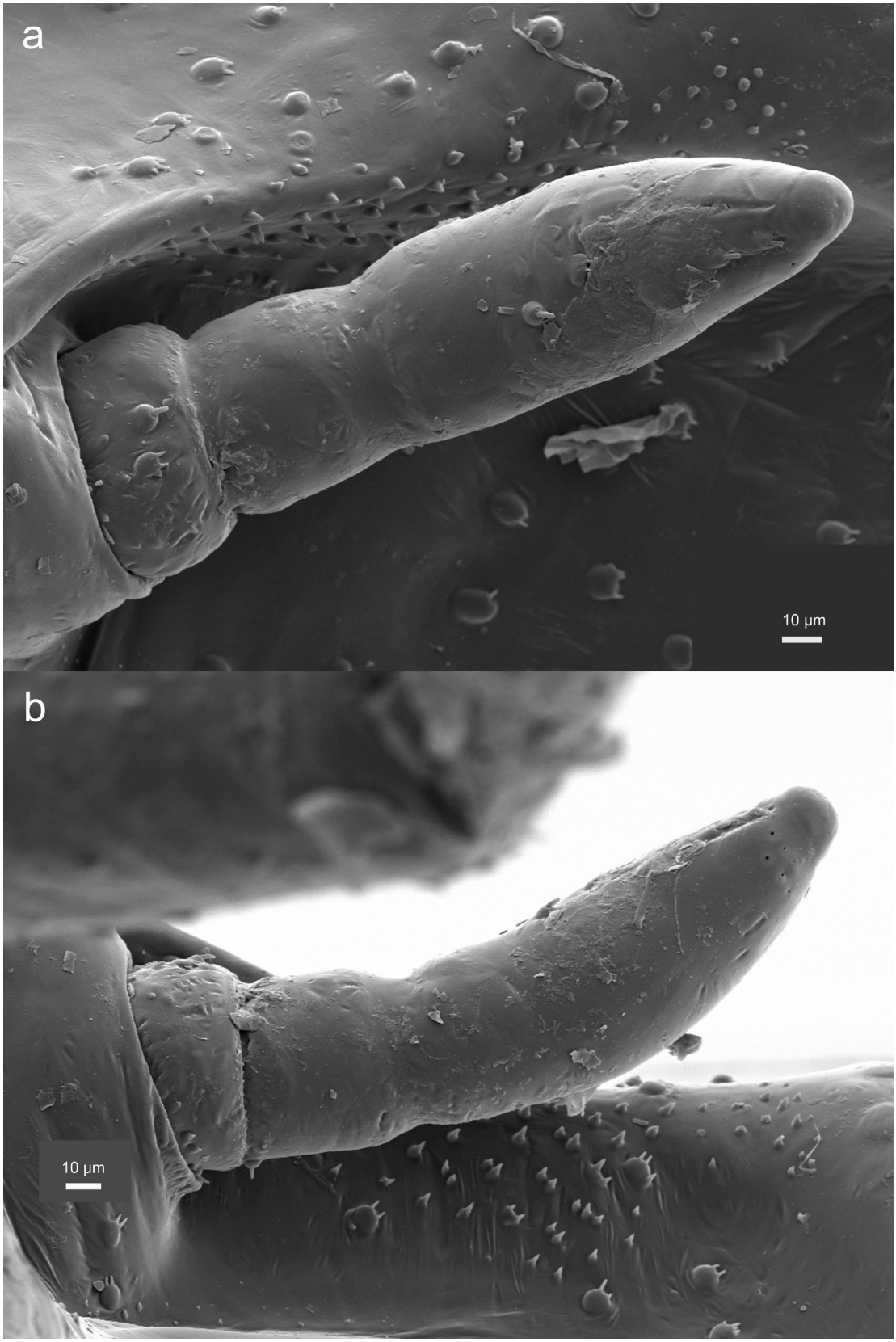


Plate fig. 7. Antennal flagellum of a fifth larval instar of *Xenophyes rhachilophus*. a – ventral view, b – caudal view. Note that the segment border between scape and pedicel is visible in the caudal view, but not in ventral view.

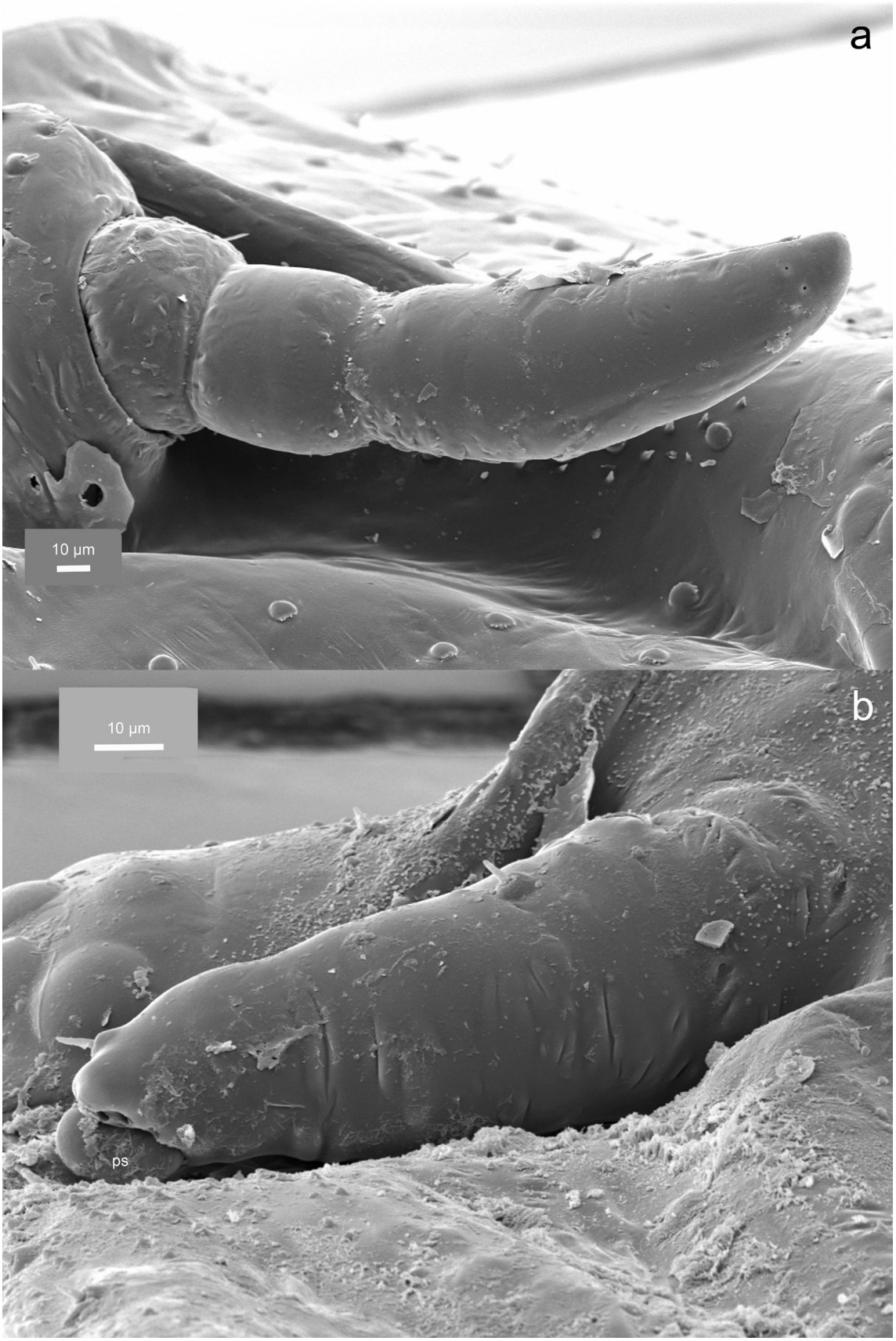


Plate fig. 8. Antennal flagella of peloridiid larvae. a – *Xenophyes cascus*, fifth instar, b – *Peloridium hammoniorum*, first instar; ps = placoid sensillum.

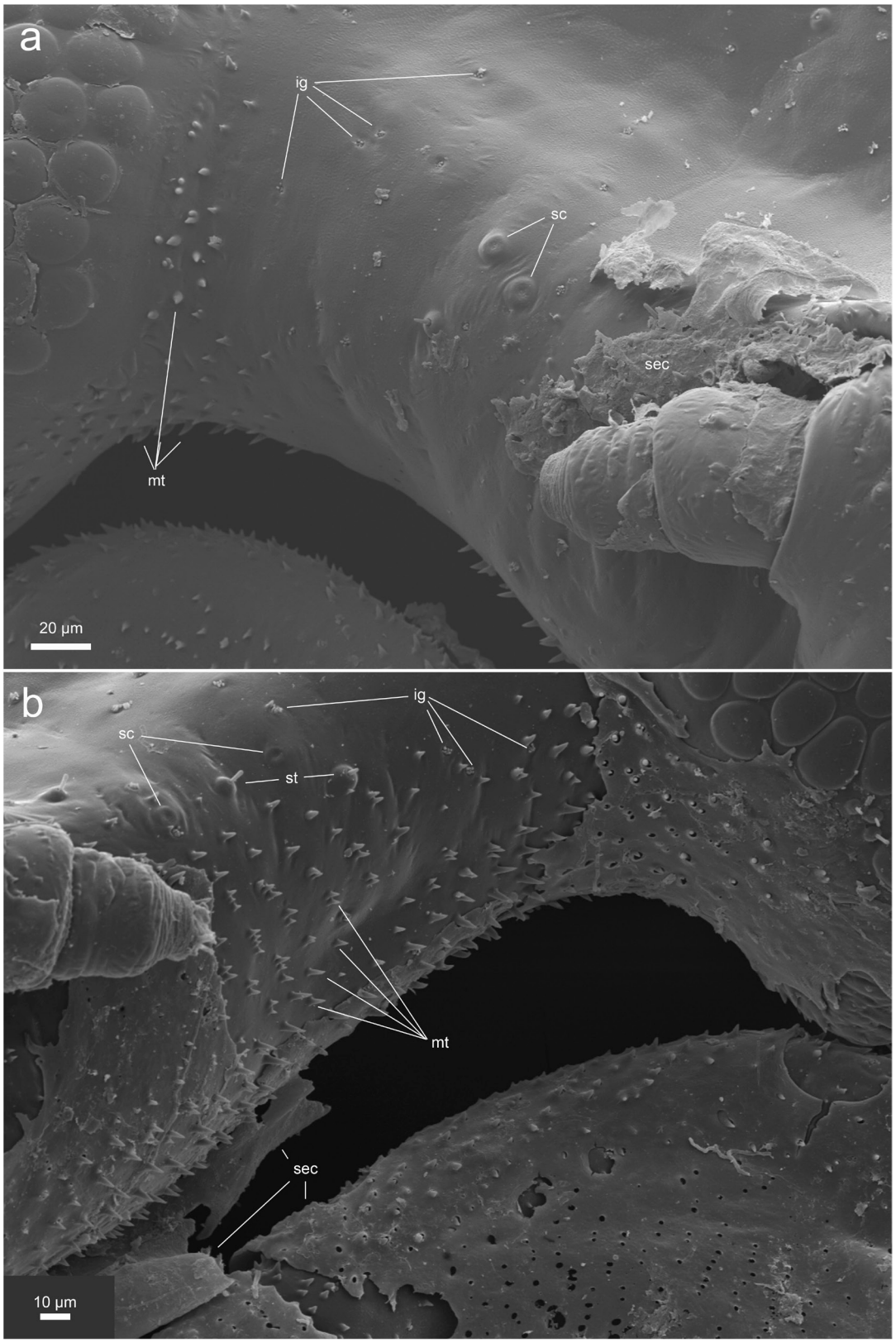


Plate fig. 9. Genal area under antenna in two males of *Xenophyes cascus*. a – from Tararua Forest Park; b – from Rimutaka Forest Park. ig = integumental glands, mt = microtrichia, sc = sensilla campaniformia, sec = superficial secretion. Note the difference in the number of microtrichia, whereas the number of other elements is quite constant.

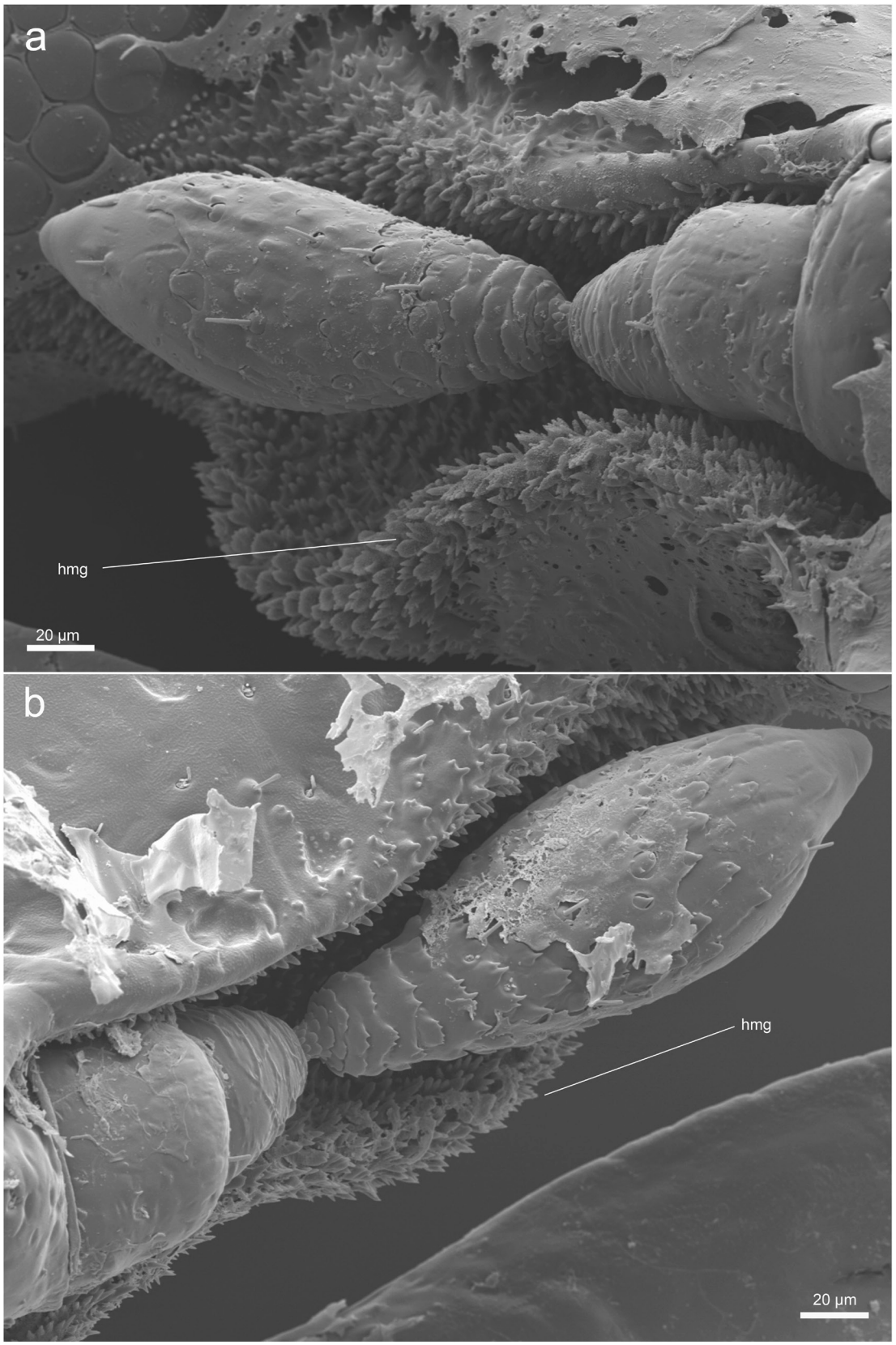


Plate fig. 10. Genal area under the antenna in two females of *Peloridium pomponorum* (both from Senda Darwin, Ancud, Chiloe, Chile; same location, same host plant *Sphagnum falcatulum*). hmg = hind margin of gena.

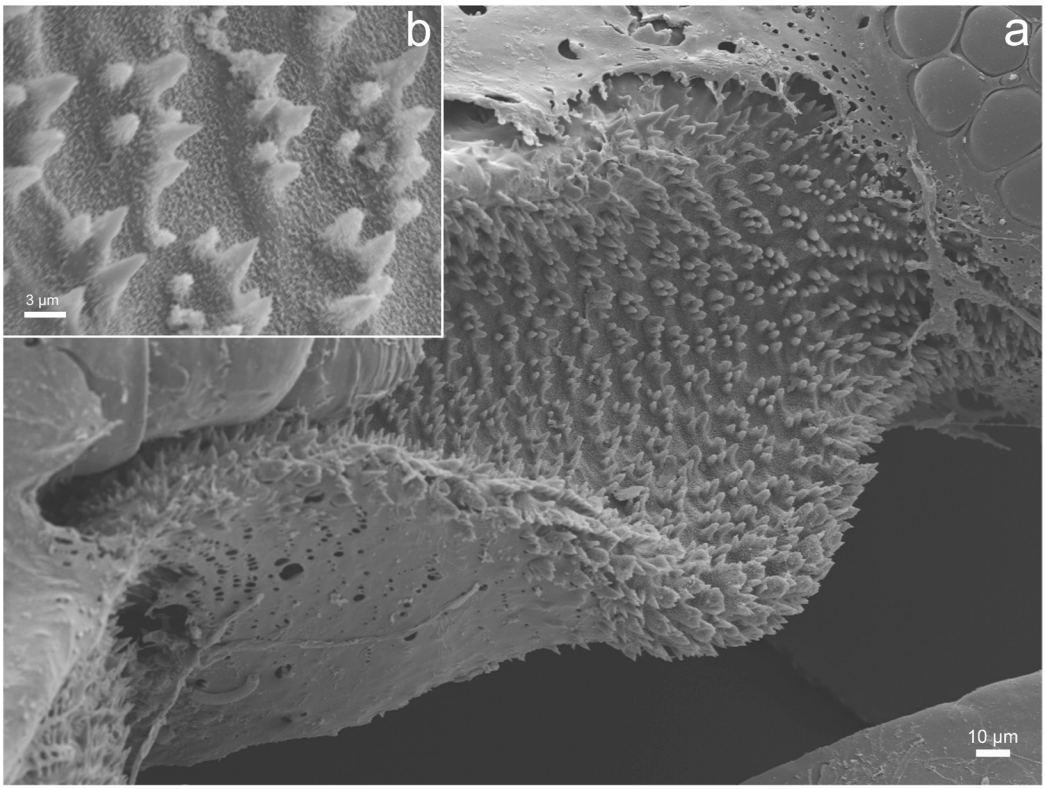


Plate fig. 11. Genal area under antenna in a female of *P. pomponorum*. a – general view, b – several microtrichia magnified. Note the waxy secretion covering the microtrichia in b.

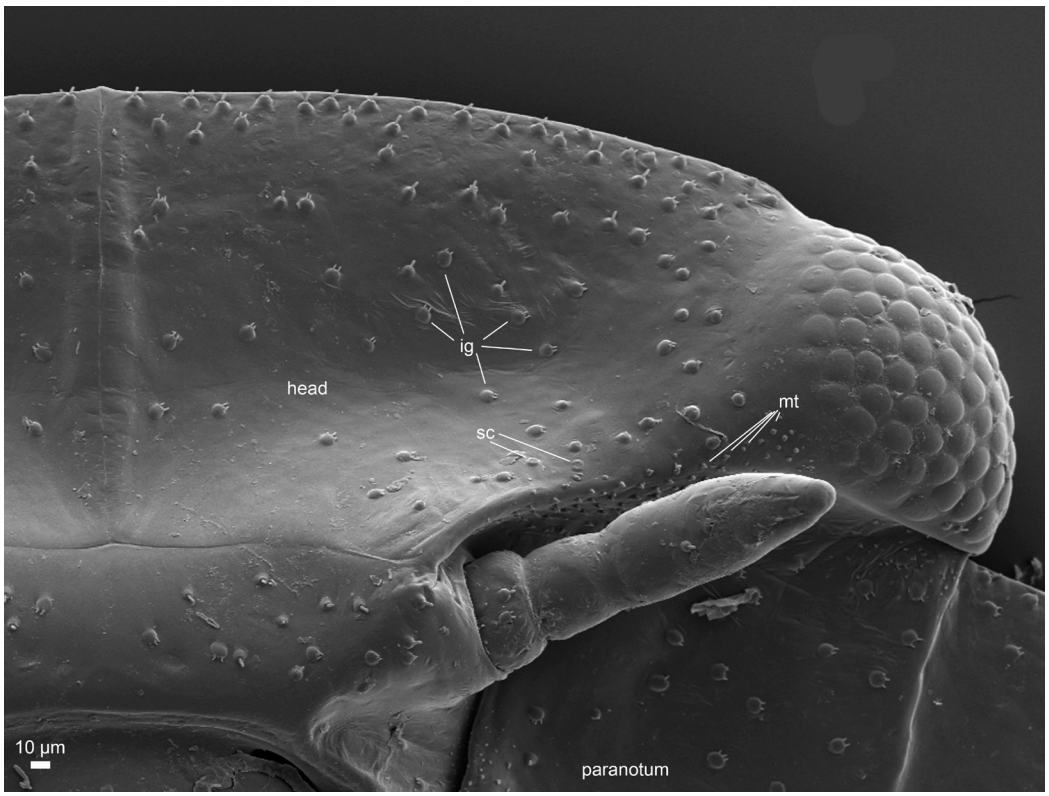


Plate fig. 12. Head and adjacent region of pronotal paranotum in a 5. larval instar of *Xenophyes rhachilophus*. ig = integumental glands, mt = microtrichia, sc = sensilla campaniformia.

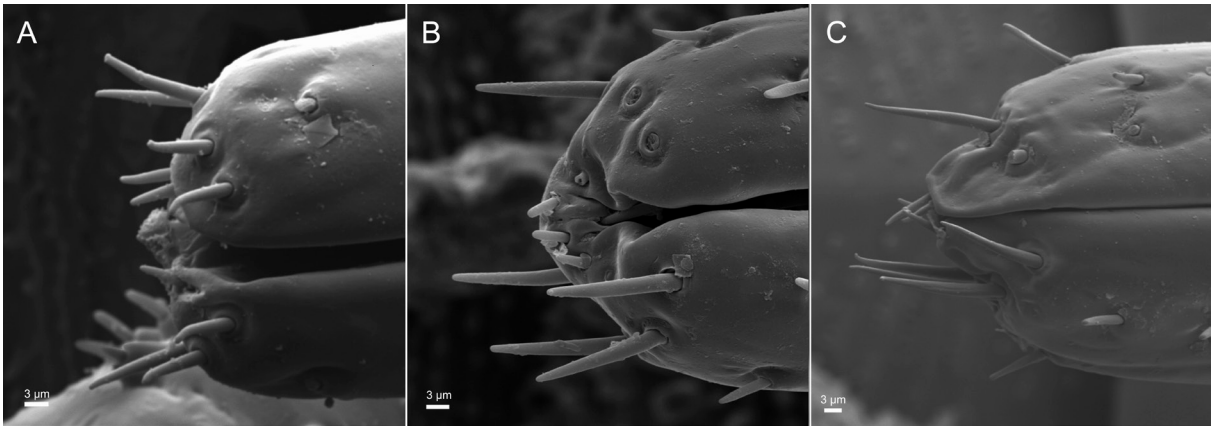


Plate fig. 13. Labium tip of Peloridiidae, ventral view. A – *Oiophysa cumberi* (flat). B – *Hackeriella echina* (skewed antisuturally). C – *Peloridium pomponorum* (lipped).

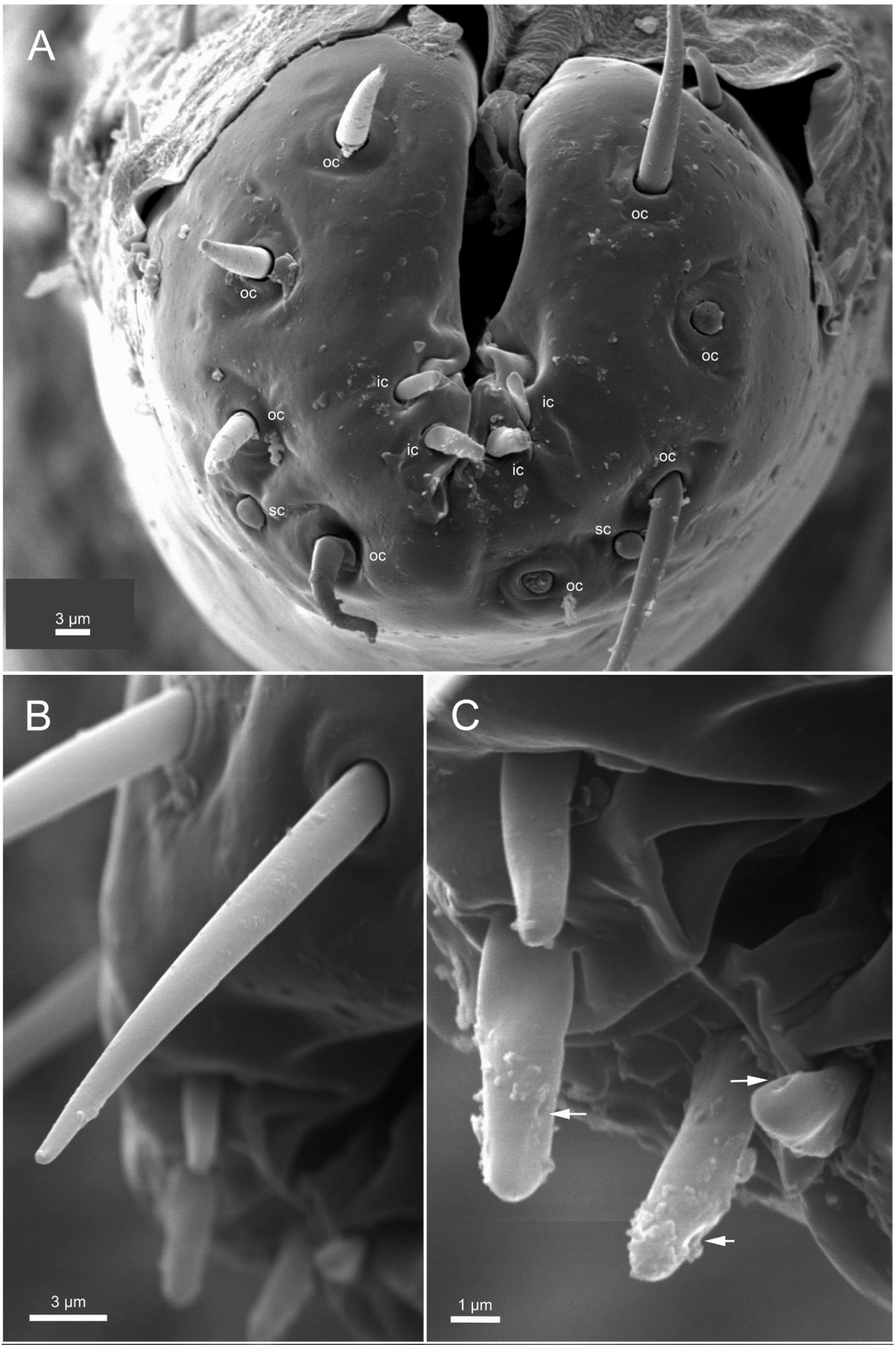


Plate fig. 14. Labium tip of Peloridiidae, caudal view, shown on *Pantinia dariwni*. A – general view; ic = inner circle (of sensilla trichodea), oc = outer circle (of sensilla trichodea), sc = sensilla coeloconica; note that some of the outer sensilla trichodea are broken off. B – an outer sensillum trichodeum. C – inner sensilla trichodea, arrows indicate pores.

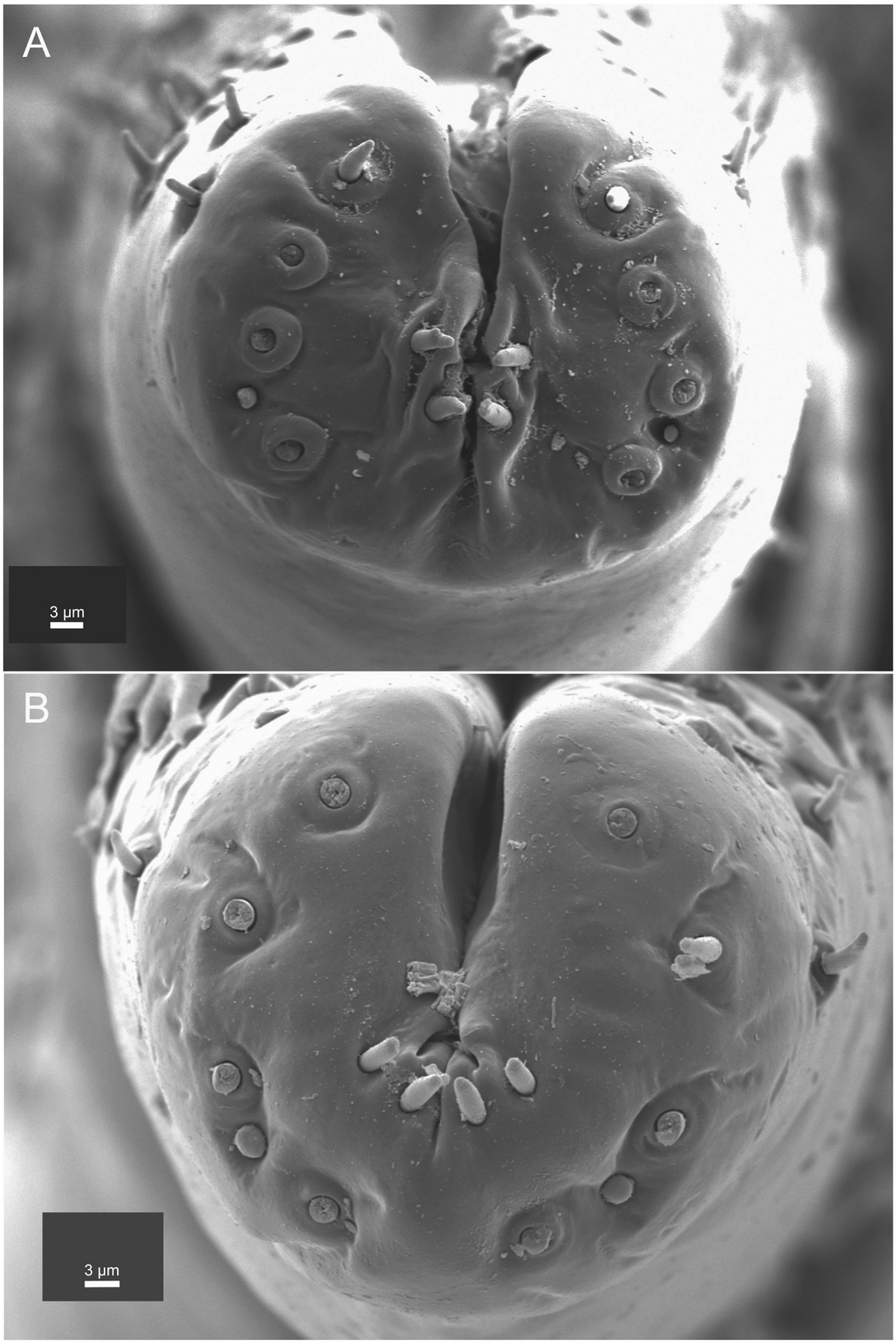


Plate fig. 15. Differences in the arrangement of inner sensilla trichodea on the labium tip. A – *Xenophyes cascus*. B – *Pantinia darwini*. The outer sensilla trichodea are almost completely broken off in both specimens.

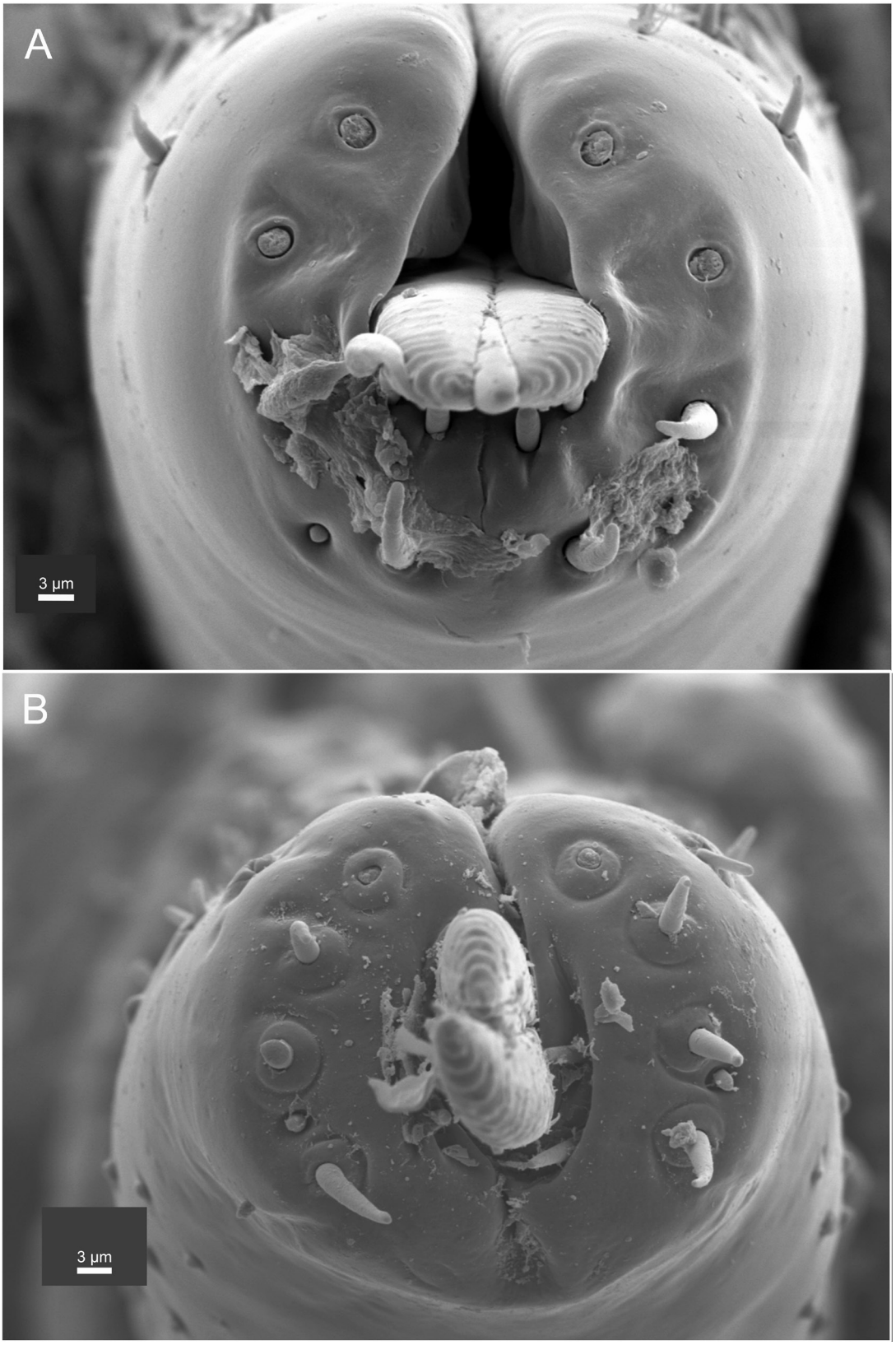


Plate fig. 16. Specimens of Peloridiidae, in which stylets stick out of the labium. A – *Peloridora holdgatei*, B – *Xenophyes cascus*. Note the different arrangement of the mandibular stylets (the barbed ones) around the maxillae, and the inner sensilla trichodea of the labium tip touching the stylet bundle.

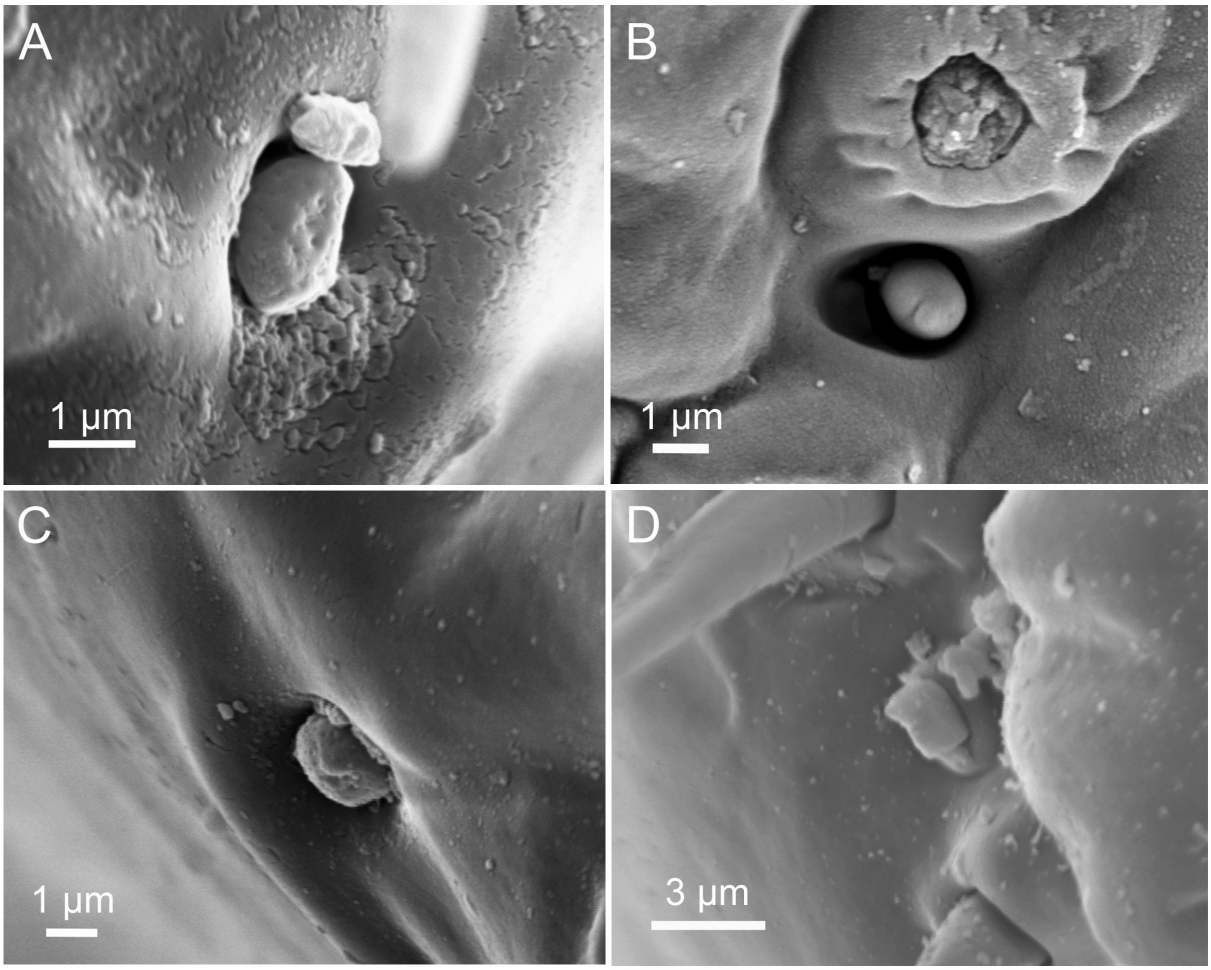


Plate fig. 17. Variation of structure in the coeloconic sensilla on the labium tip in Peloridiidae. A – *Hemiodoecus crassus* (multiporous). B – *Xenophyes rhachilophus* (terminal pore). C – *Hemiodoecus leai* (multiporous with a terminal pore). D – *Peloridium pomponorum* (socketed).

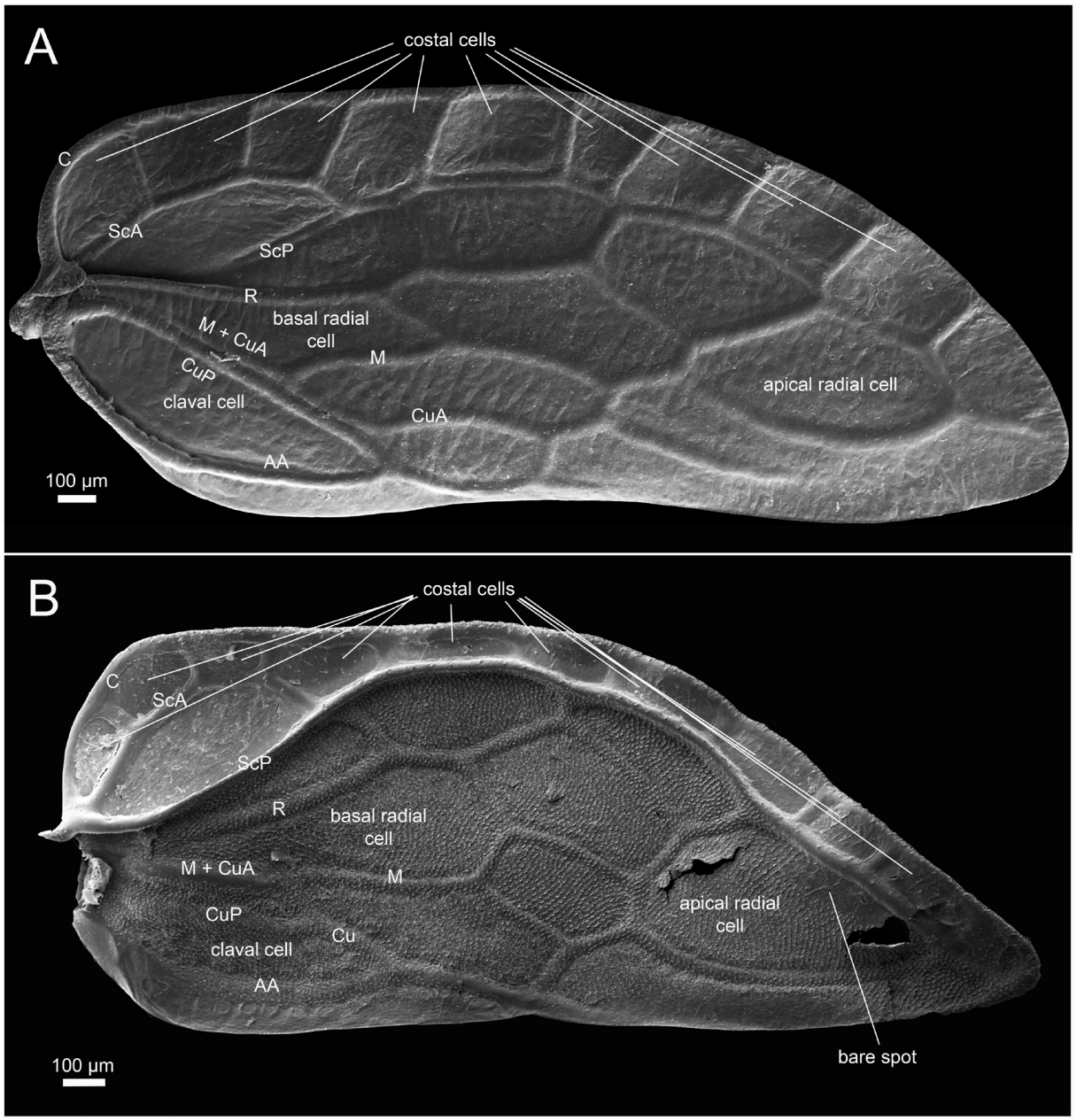


Plate fig. 18. Tegmina venation in Peloridiidae. A – *Peloridium pomponorum*, B – *Hemiodoecus acutus*. AA = anterior anal vein, C = costa, Cu = cubitus, CuA = cubitus anterior, CuP = cubitus posterior, M = media, R = radius, ScA = subcosta anterior, ScP = subcosta posterior.

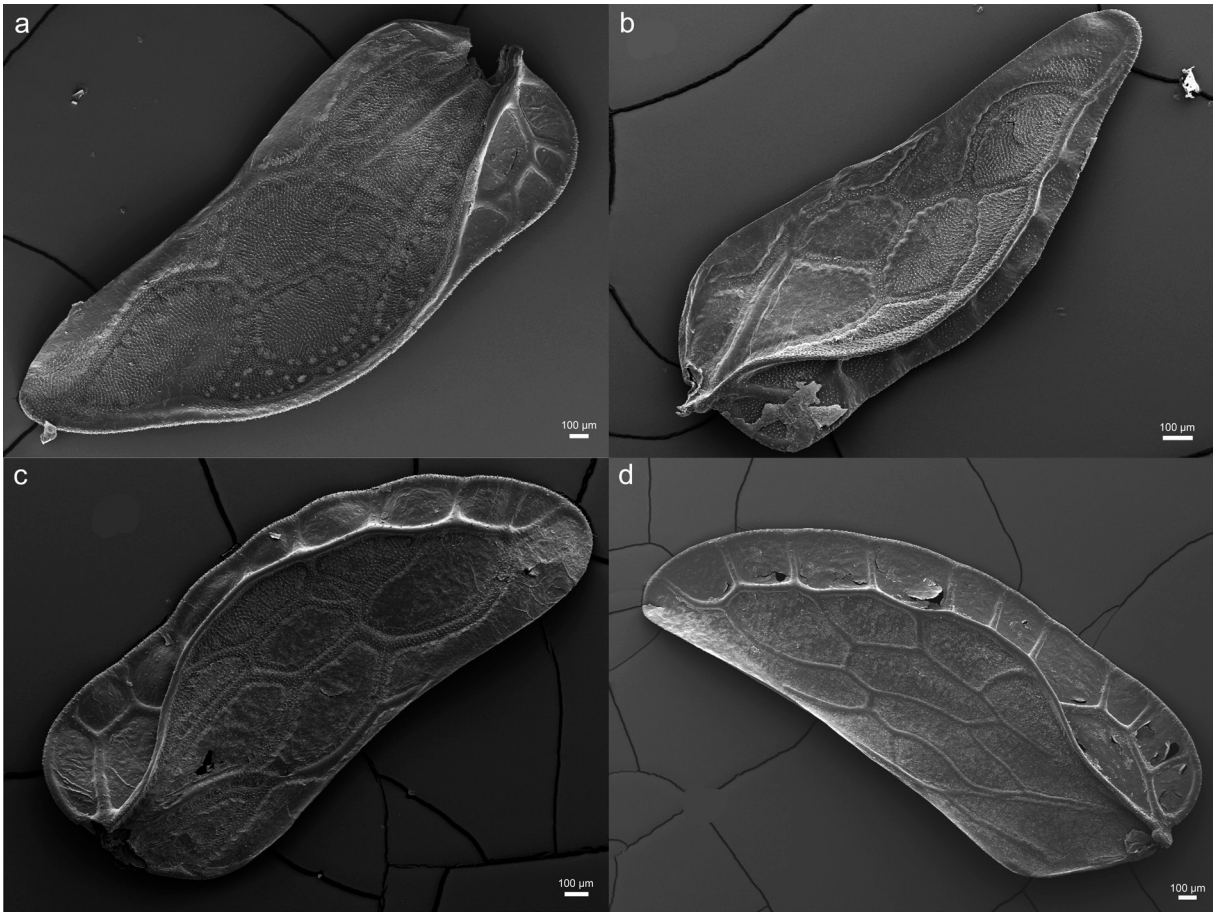


Plate fig. 19. Different degree of extension of cuticular sculpture on ventral side of the tegmen in Peloridiidae. a – *Hackeriella brachycephala*; b – *Oiophysa ablusa*; c – *Hemiodoecellus fidelis*; d – *Peloridium hammoniorum*.

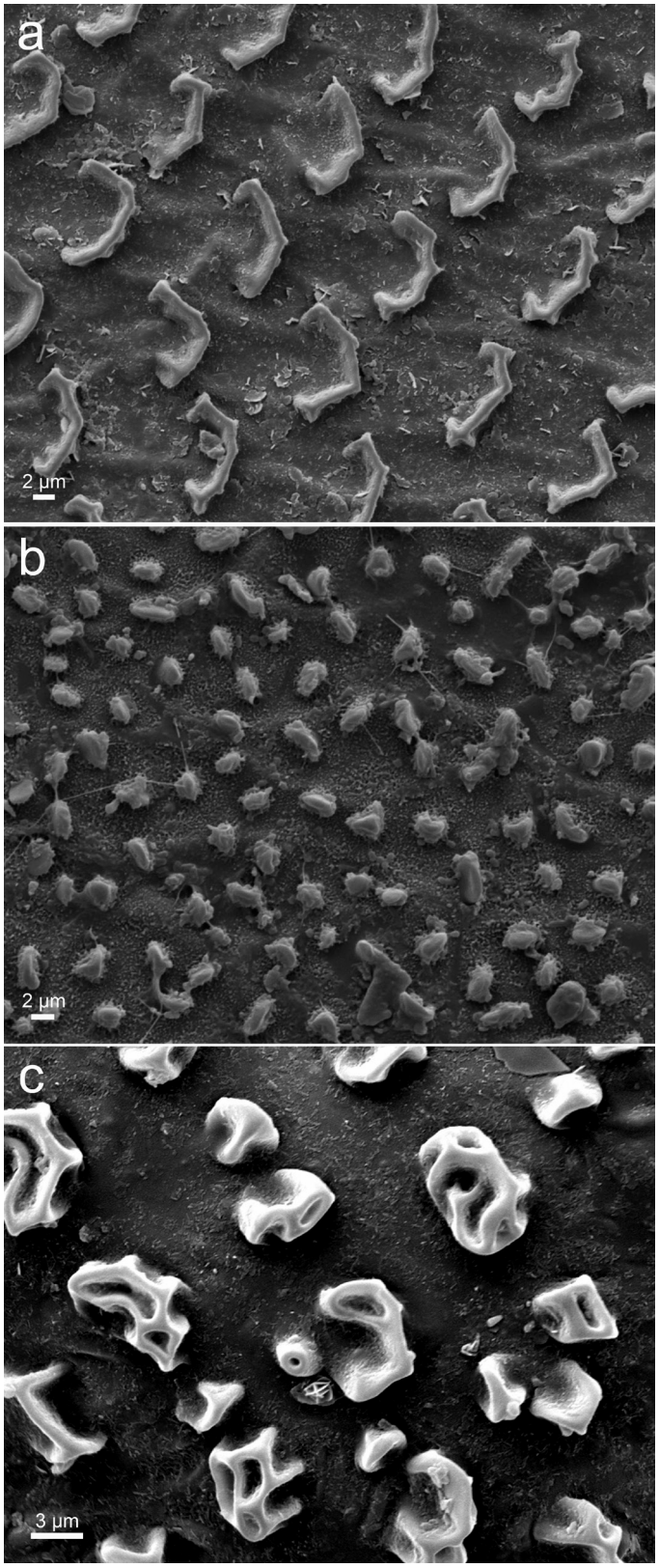


Plate fig. 20. Various forms of cuticular sculpture elements on ventral side of the tegmen in Peloridiidae. a – *Hemiodeocus leai*, scales; b – *Idophysa chonos*, pegs; c – *Hackeriella brachycephala*, compressed scales.

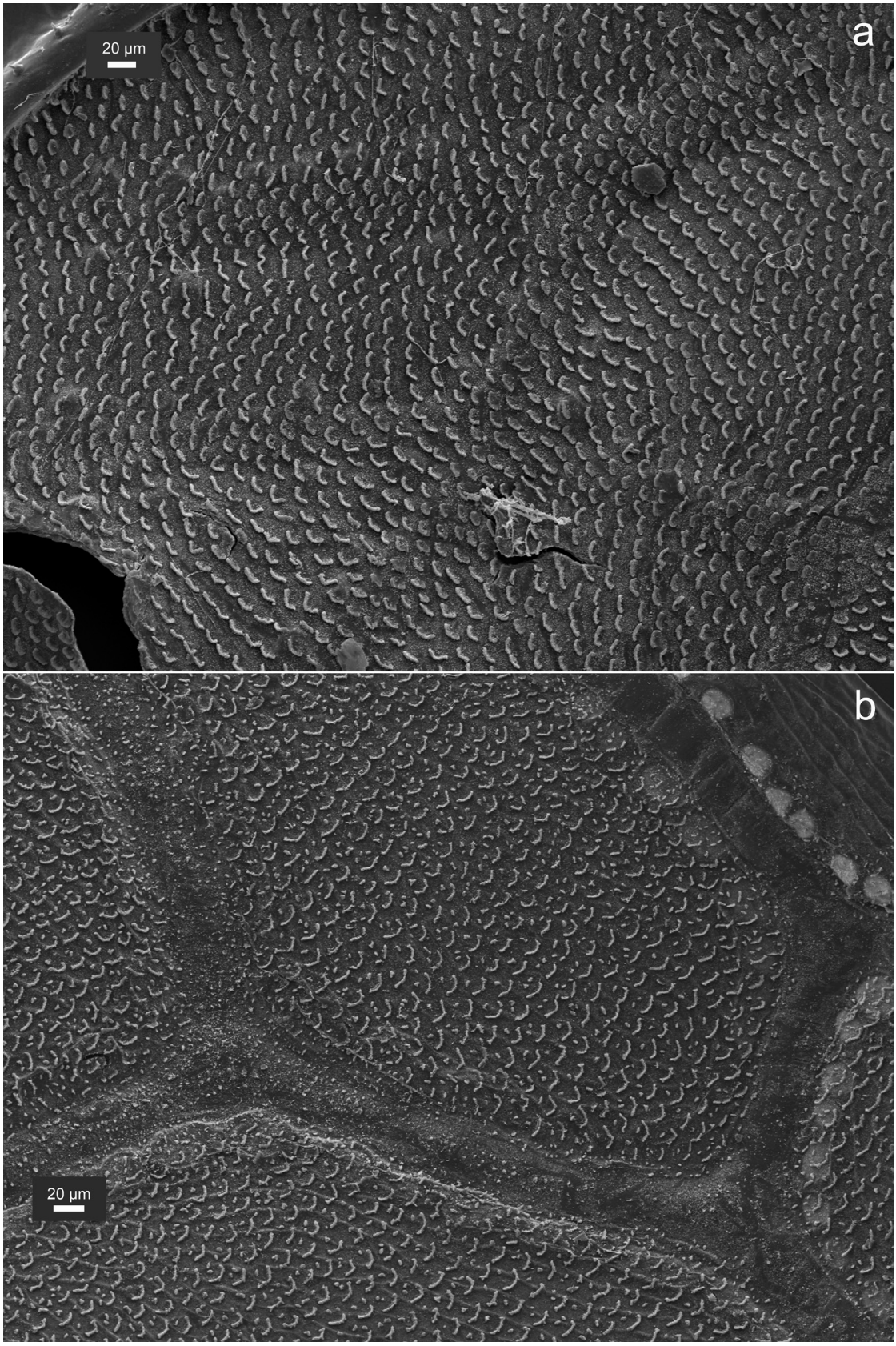


Plate fig. 21. Intraspecific diversity of sculptural elements on tegmina of Peloridiidae. a – *Xenophysella greensladeae*, elements uniform; b – *Pantinia darwini*, several types of elements recognizable.

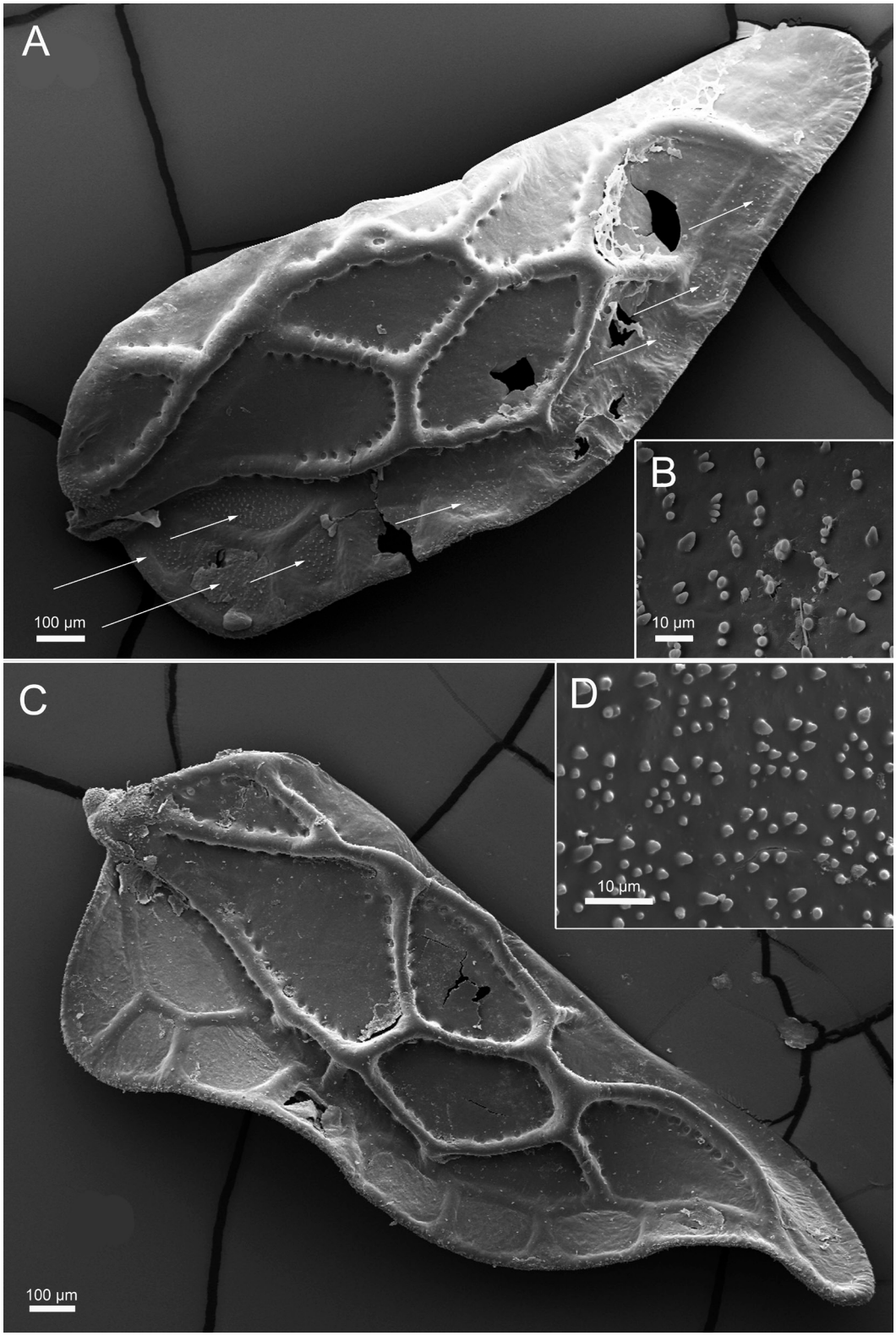


Plate fig. 22. Dorsal surface of tegmina in Peloridiidae. A – *Oiophysa ablusa*; arrows indicate regions with cuticular sculpture. B – sculptured region from A, magnified. C – *Oiophysa distincta*; note that the regions homologous to those that bear sculpture in *O. ablusa* are free from sculptural elements in this species. D – dorsal sculpture on tegmen of *Oiophysa cumberi*; note the differences in size and arrangement to *O. ablusa.*

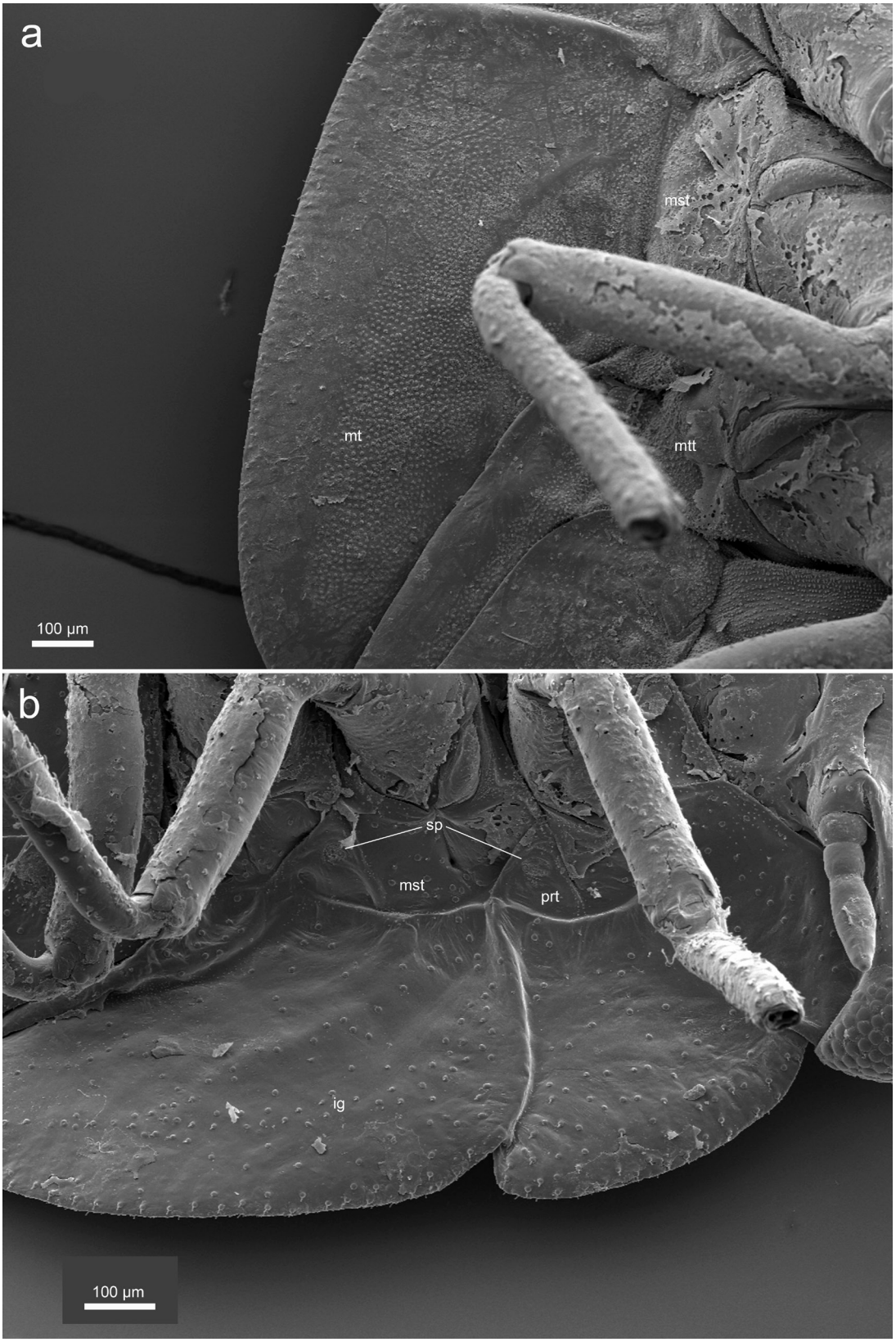


Plate fig. 23. Sculpture on ventral side of the tegmina in larvae of Peloridiidae. a – *Peloridium hammoniorum*, thorax, 5th instar; mst = mesothorax, mt = microtrichia, mtt = metathorax; b – *Xenophyes cascus*, thorax, 5th instar; ig = integumental glands, mst = mesothorax, prt = prothorax, sp = spiracles.

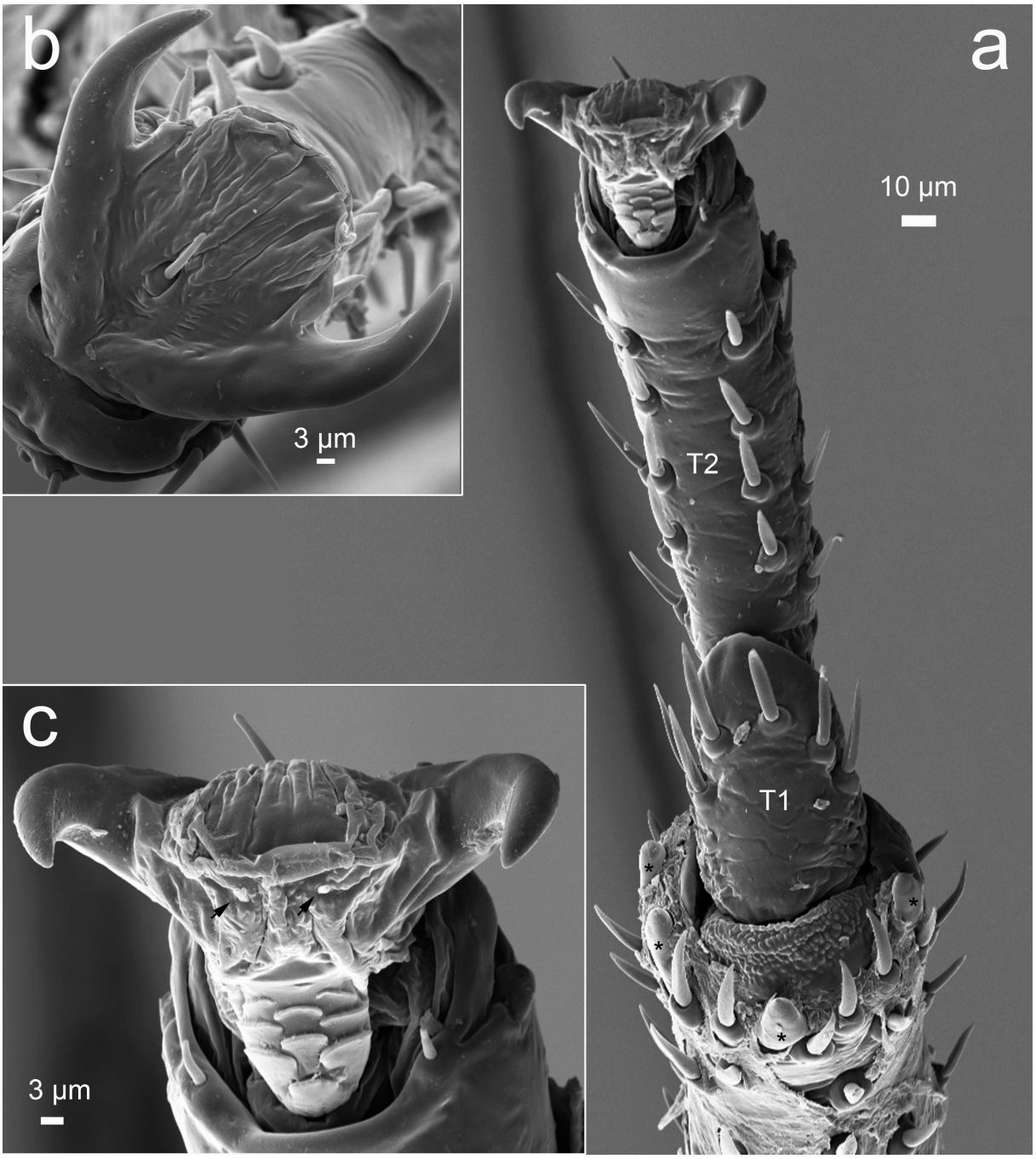


Plate fig. 24: Distal region of a hind leg of *Hackeriella echina*. a – general view, tibial spurs are indicated with asterisks; b – pretarsus (ventral view), black arrows point at the setae on the arolium; c – pretarsus (dorsal view).

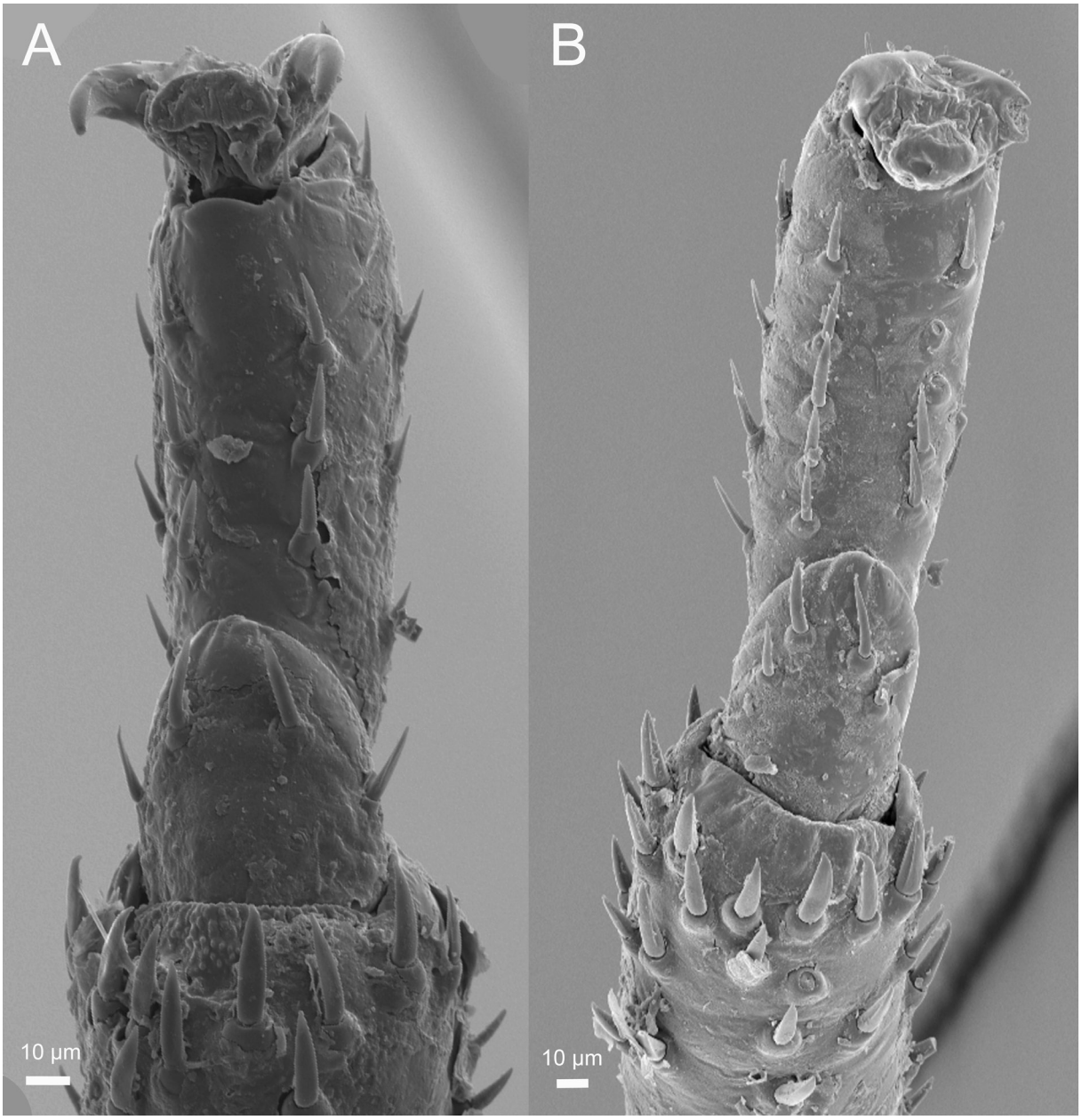


Plate fig. 25. Distal region of hind legs in larvae of Peloridiidae (5th instar). A – *Hackeriella brachycephala*, B – *Peloridium hammoniorum*. Note that the tibia only carries socketed setae distally (tibial spurs typical for the adults are absent).

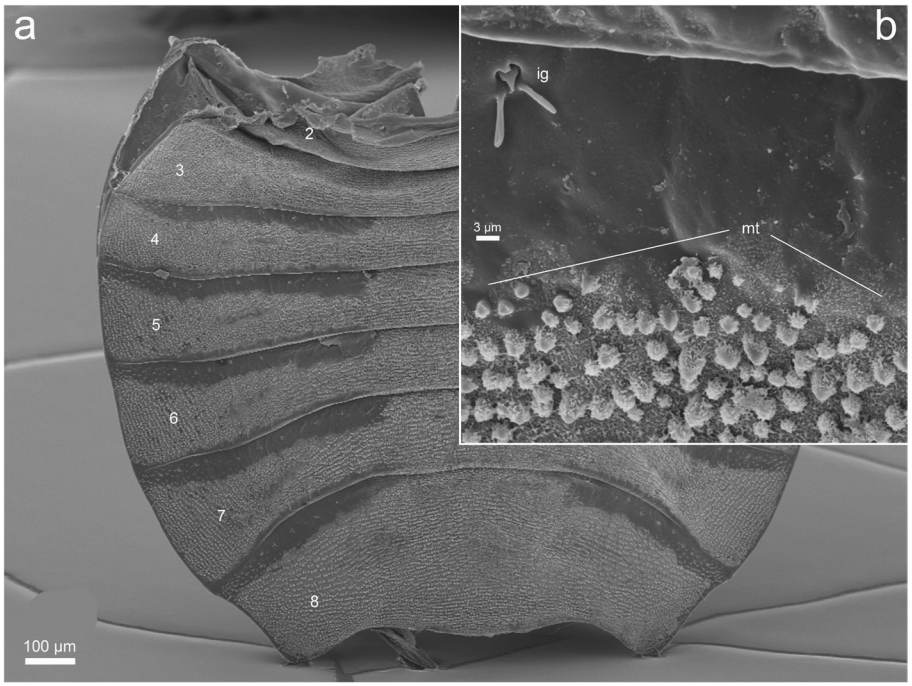


Plate fig. 26. Dorsal abdomen with plastron structures of *Peloridora holdgatei*. a – general view; numbers indicate the abdominal segments; dark grey parts are free from wax, light grey are covered with it; b – a detail of a, magnified; ig = integumental gland, mt = microtrichia (covered with wax).

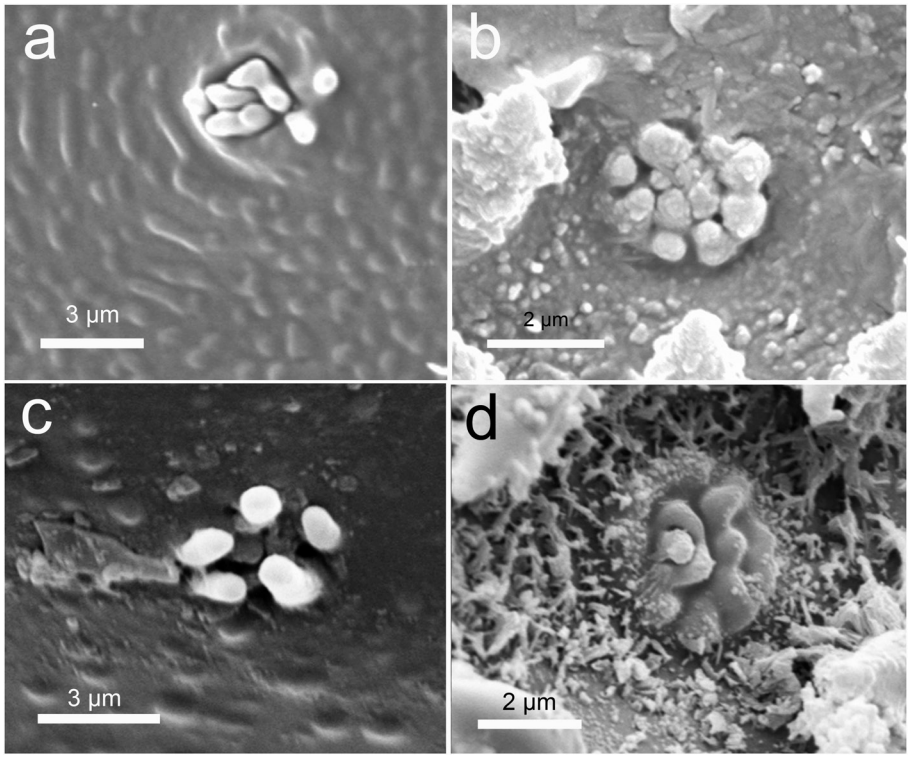


Plate fig. 27. Integumental glands under plastron structures in comparison to glands elsewhere on the body. a – *Xenophyes cascus*, ventral surface of thorax; b – *X. cascus*, plastron (abdominal dorsum); c – *Oiophysa ablusa*, dorsal surface of a tegmen; d – *O. ablusa*, plastron (abdominal dorsum). Note that the structure of glands in a and b are quite smiliar, whereas in c and d it is different.

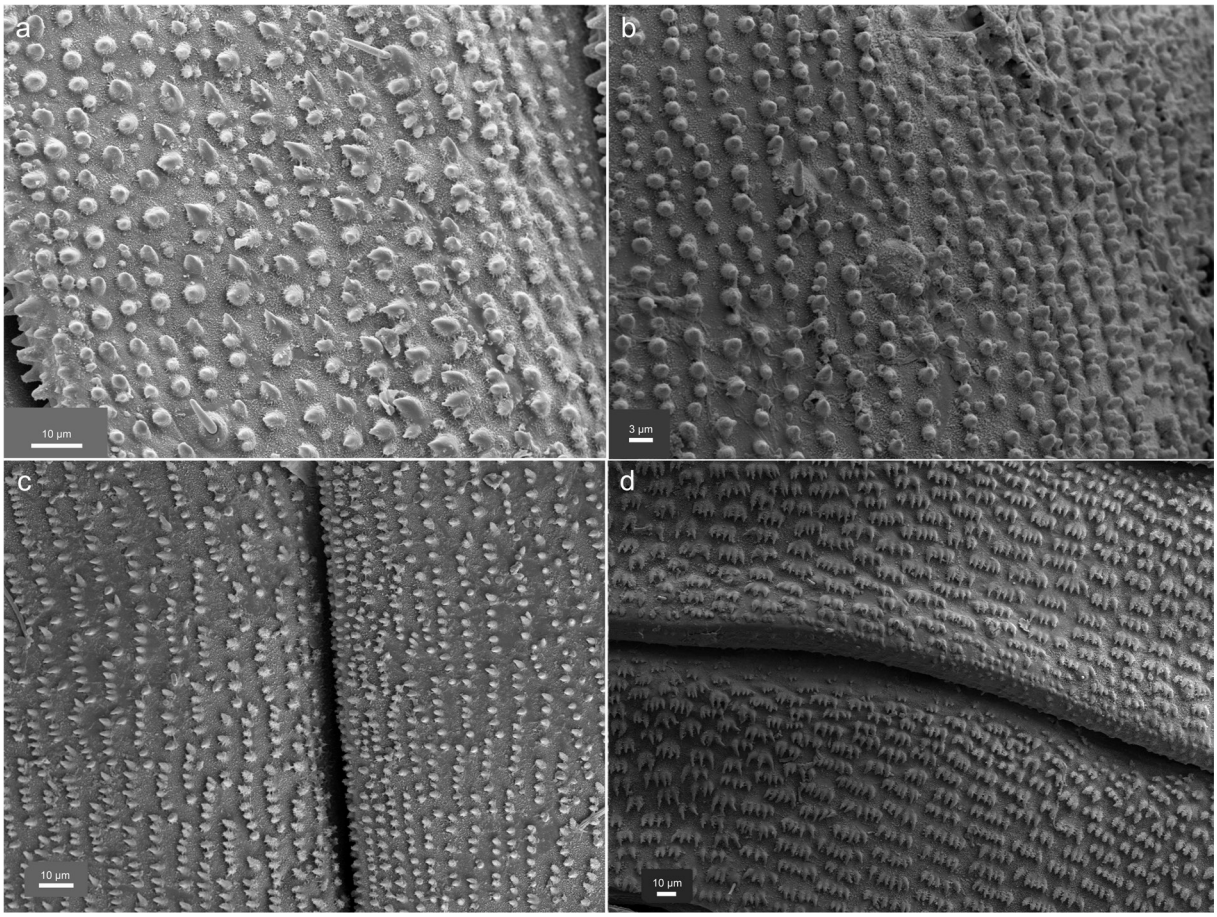


Plate fig. 28. Microtrichia arrangements in plastron of different species of Peloridiidae. a – *Hackeriella brachycephala*, microtrichia single, not organized in rows or groups; b – *Peloridium hammoniorum*, microtrichia single, organized in rows but not in recognizable groups; c – *Hemiodoecus acutus*, microtrichia single, organized in groups of 5-7 that are arranged in rows; d – *Xenophysella greensladeae*, microtrichia joined on the base.

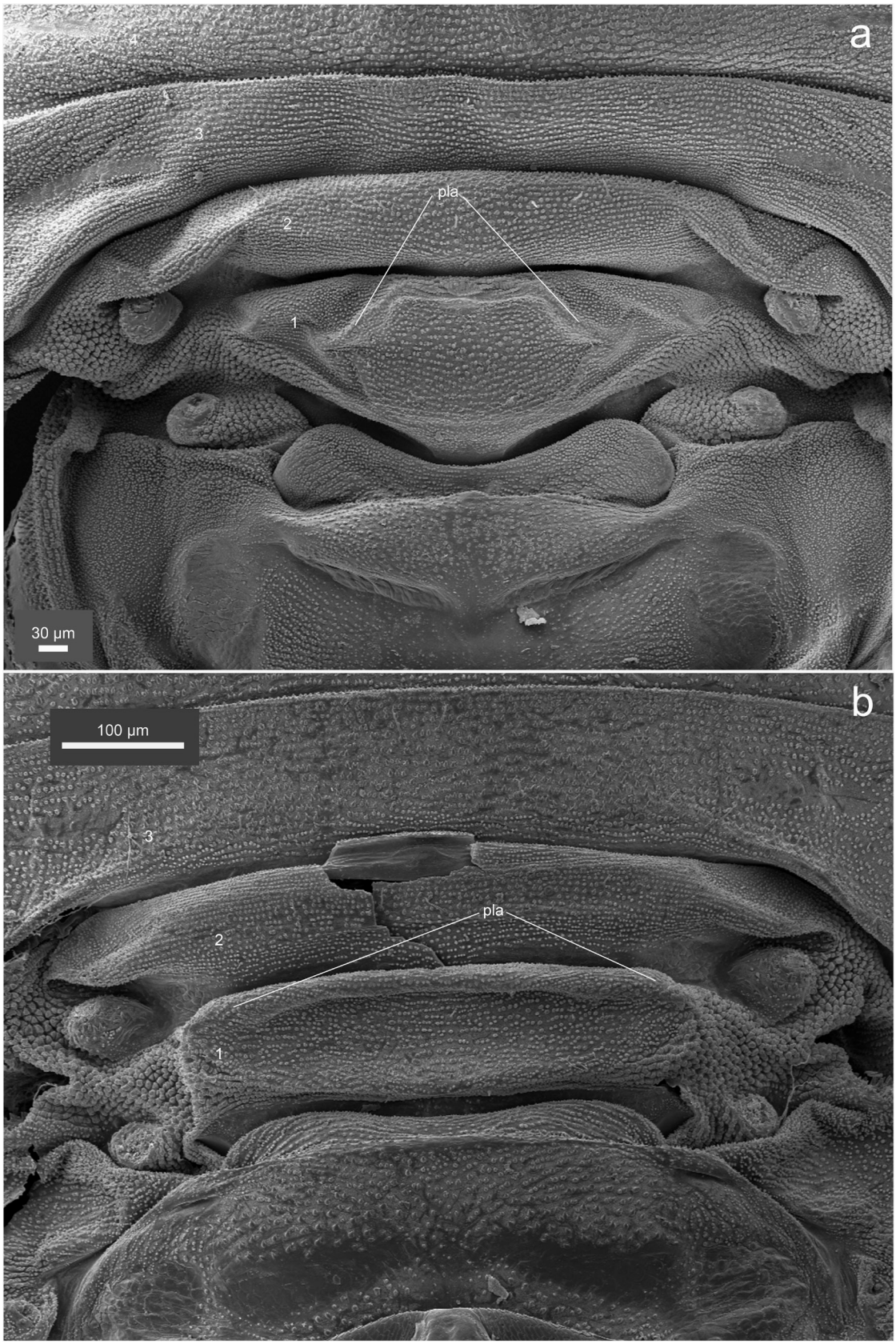


Plate fig. 29. Differences in the form of the first abdominal tergite in Peloridiidae. a – *Hackeriella brachycephala*, male. B – *Oiophysa cumberi*, male. pla = posterolateral apodemes; abdominal tergites are numbered.

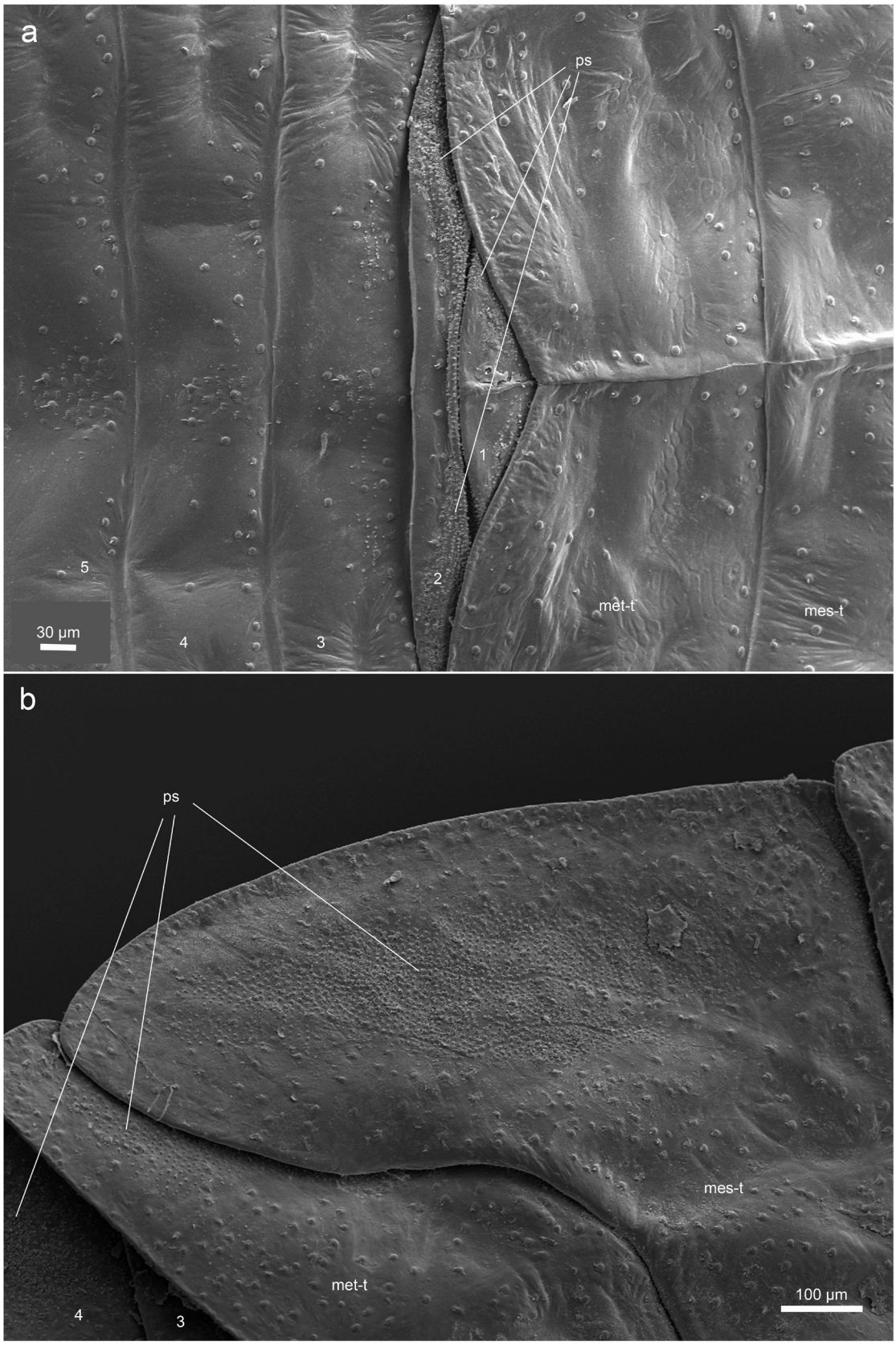


Plate fig. 30. Plastron structures in larvae of Peloridiidae. a – 5th instar of *Xenophyes cascus*, dorsal view. b – 5th instar of *Peloridium hammoniorum*, dorsal view. mes-t = mesothorax, met-t = metathorax, ps = plastron structures; abdominal tergites are numbered.

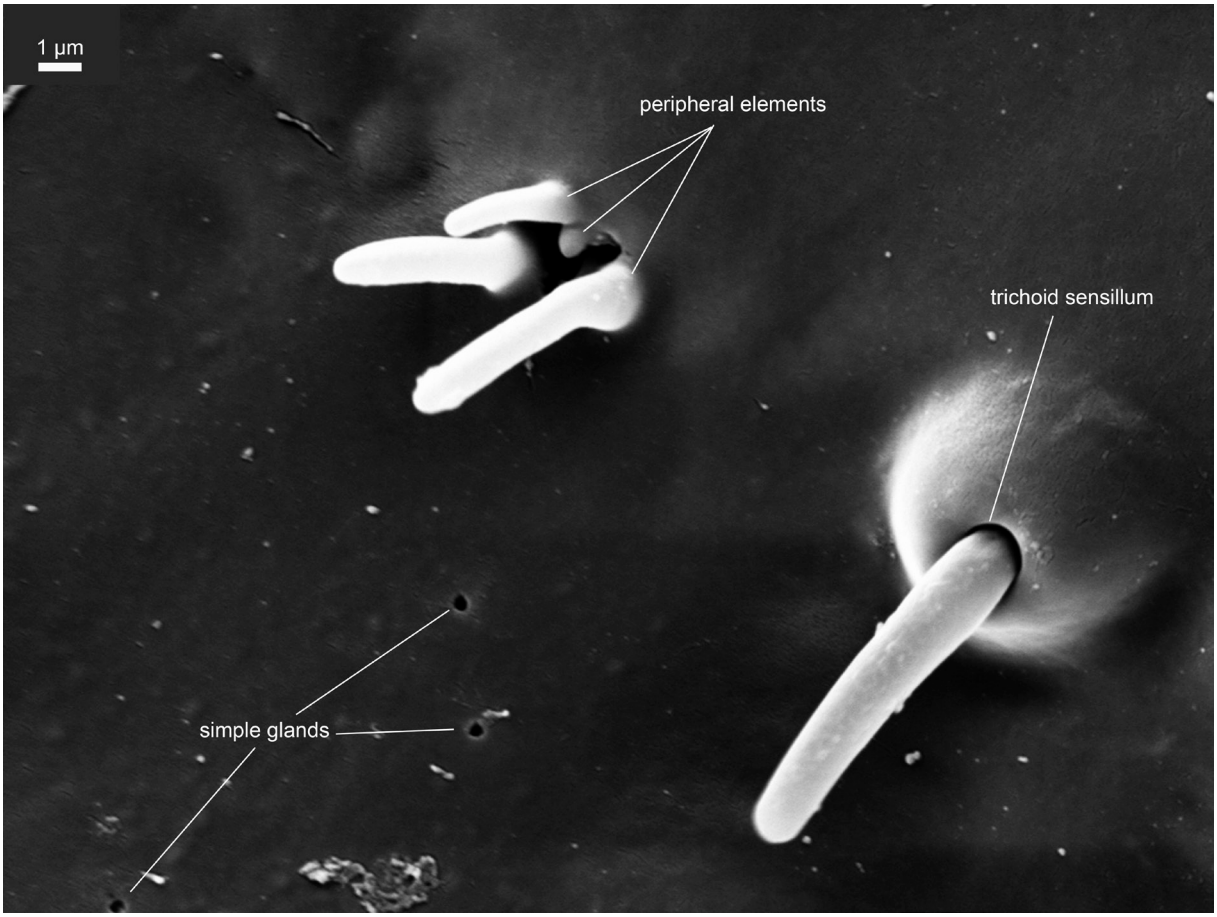


Plate fig. 31. Integumental glands on dorsal side of the head in adult *Hackeriella brachycephala*. Three simple glands on the lower left side and one “floral” gland whose opening is surrounded by finger-like peripheral elements; a trichoid sensillum is also present.

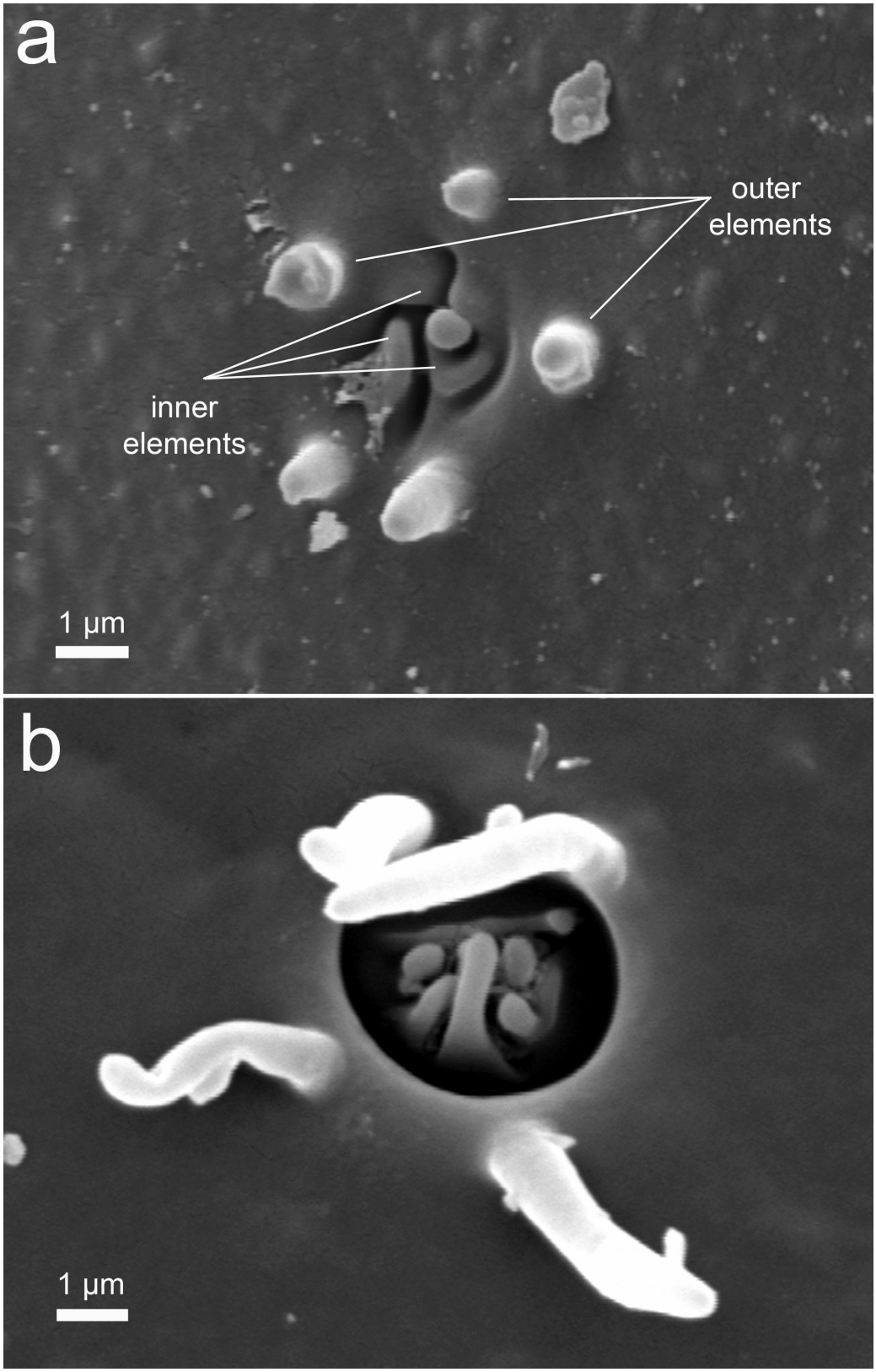


Plate fig. 32. Variability of integumental glands. a - integumental gland on the dorsal side of the tegmen in *Xenophyes rhachilophus*. Inner elements lying flat on the grand and surround the gland opening, making it strongly sinuous. b – integumental gland on the dorsal side of the head in *Pantinia darwini*. Note the sunk-in inner elements.

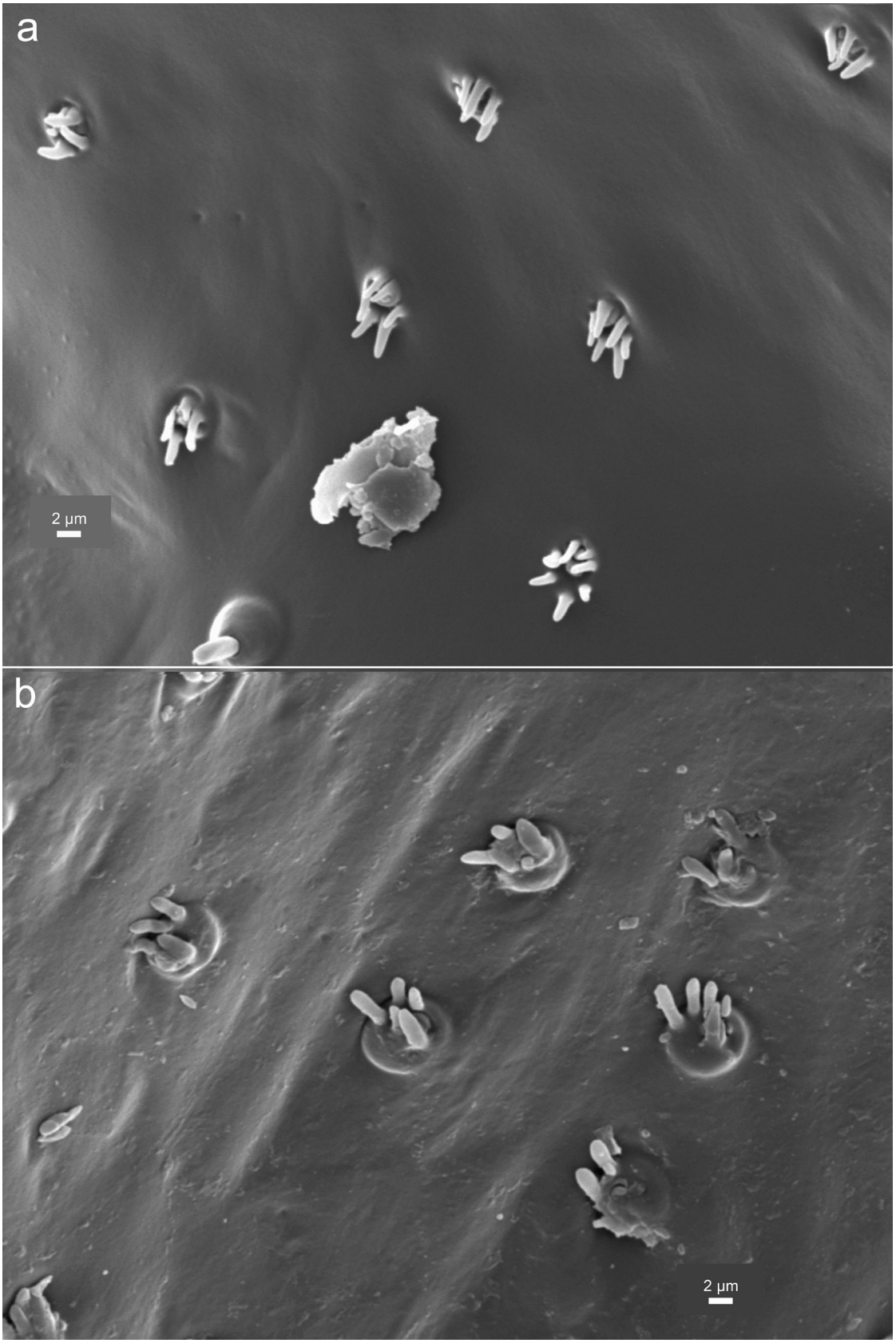


Plate fig. 33. Variability of integumental glands in *Hemiodoecellus fidelis* (same individual). a – on paranotum; b – on dorsal side of the head. Note the elevated bases that are present in b, but absent in a.

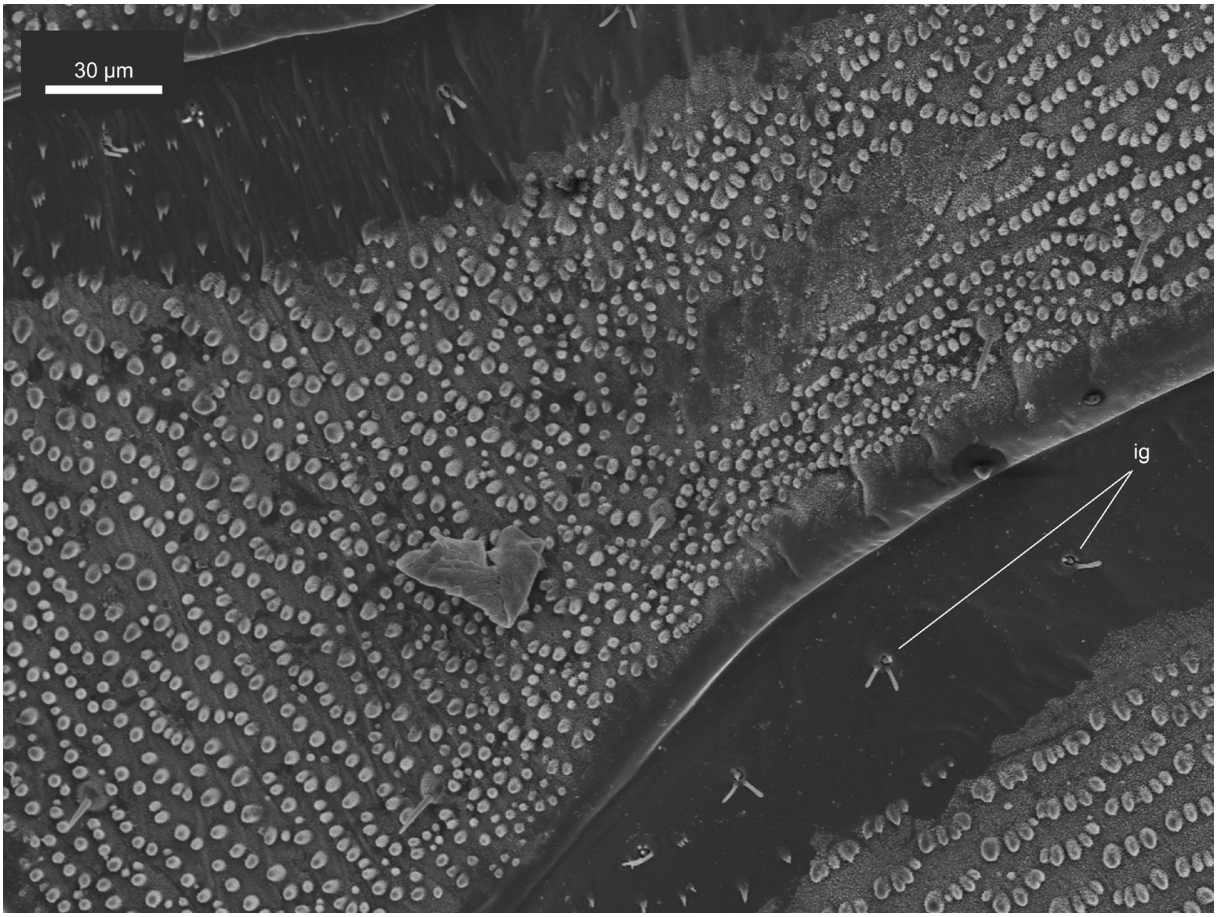


Plate fig. 34. Integumental glands (ig) on abdominal tergites of *Peloridora holdgatei*. Note that they are only present on the parts that are free of sculpture and wax covering.

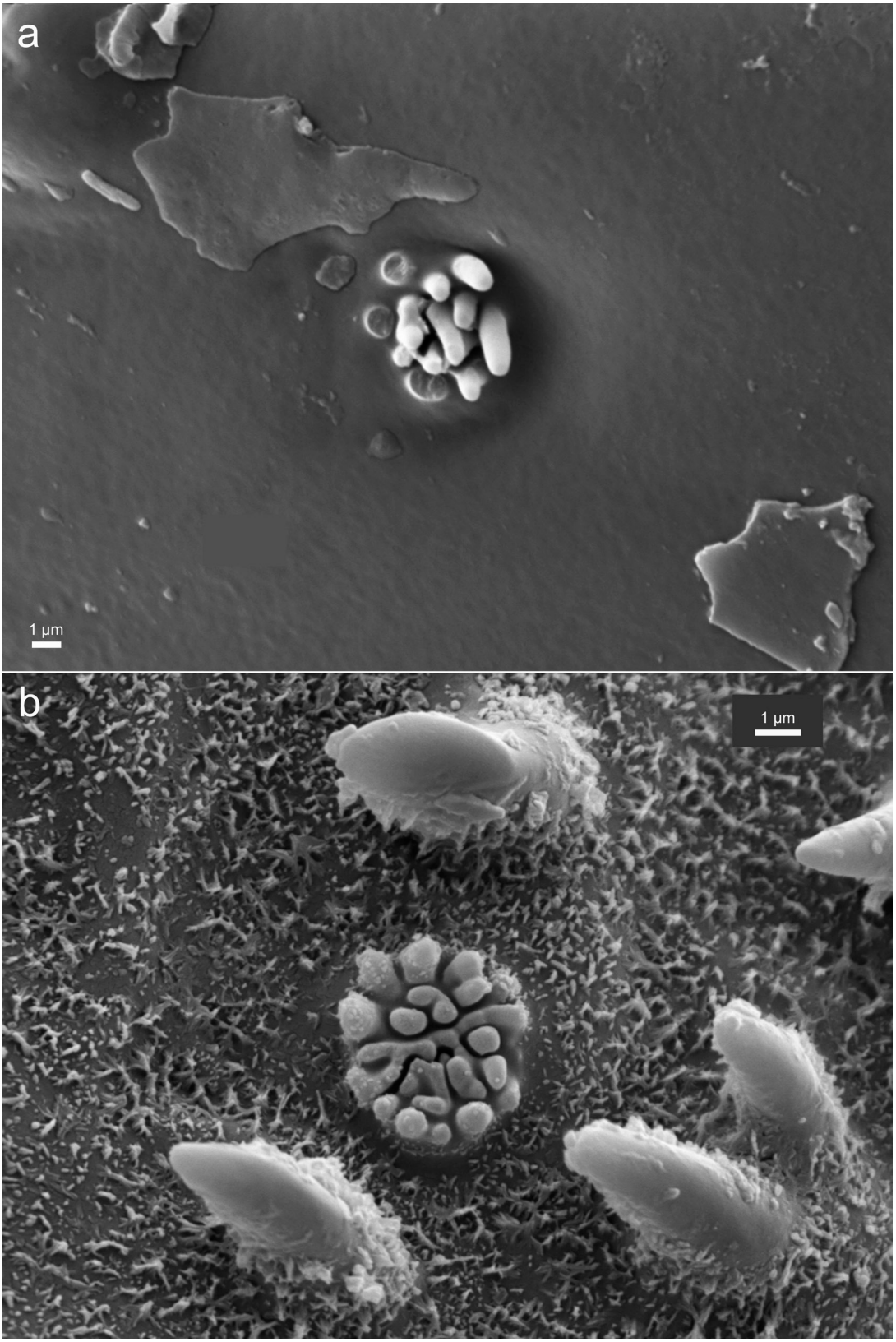


Plate fig. 35. Variability of integumental glands in *Xenophyes kinlochensis*. a – on pronotum; b – on an abdominal tergite occupied by plastron; note the wax-like secretion covering the surface. The peripheral elements in b are smaller and there is at least one cross-piece, something that does not occur in integumental glands elsewhere.

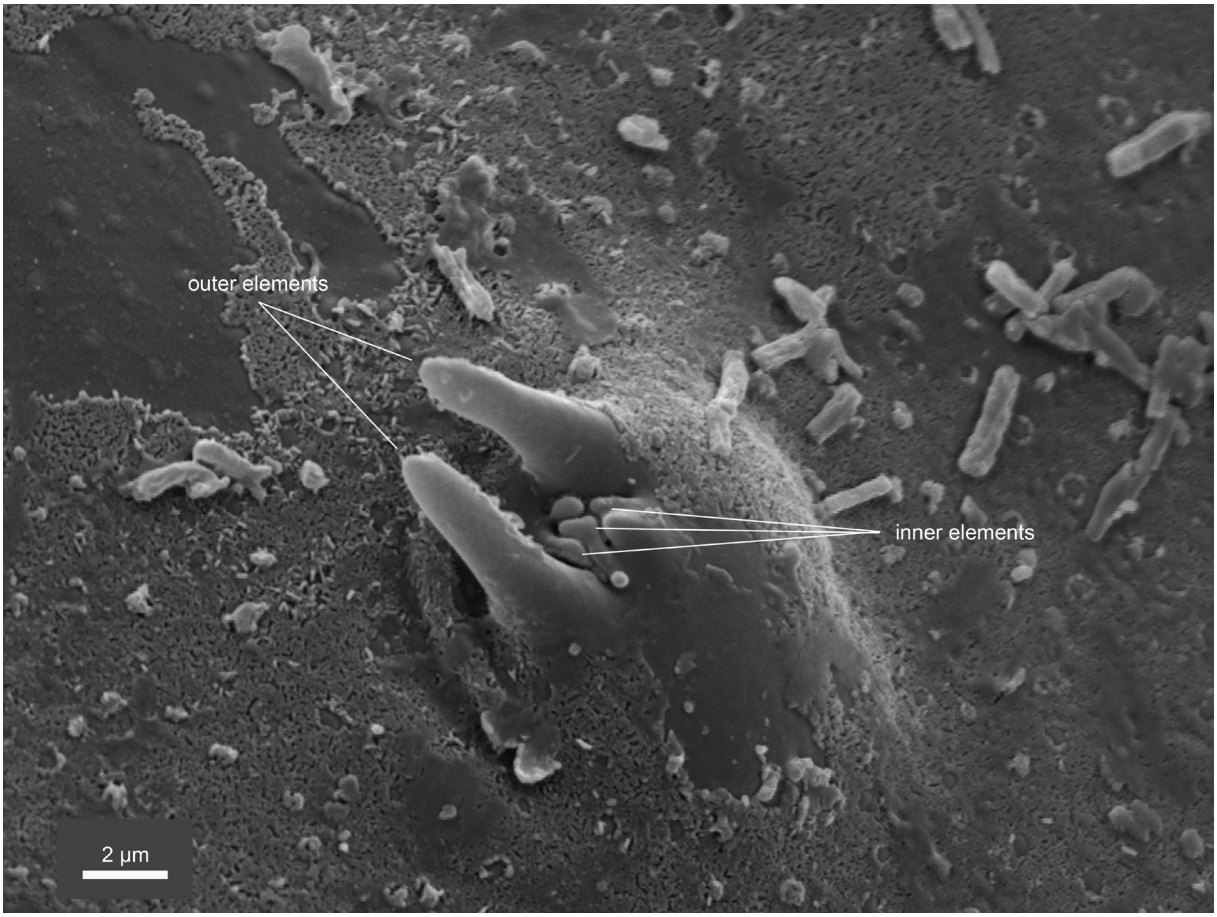


Plate fig. 36. Integumental gland in a 5th instar larva of *Peloridium hammoniorum*.

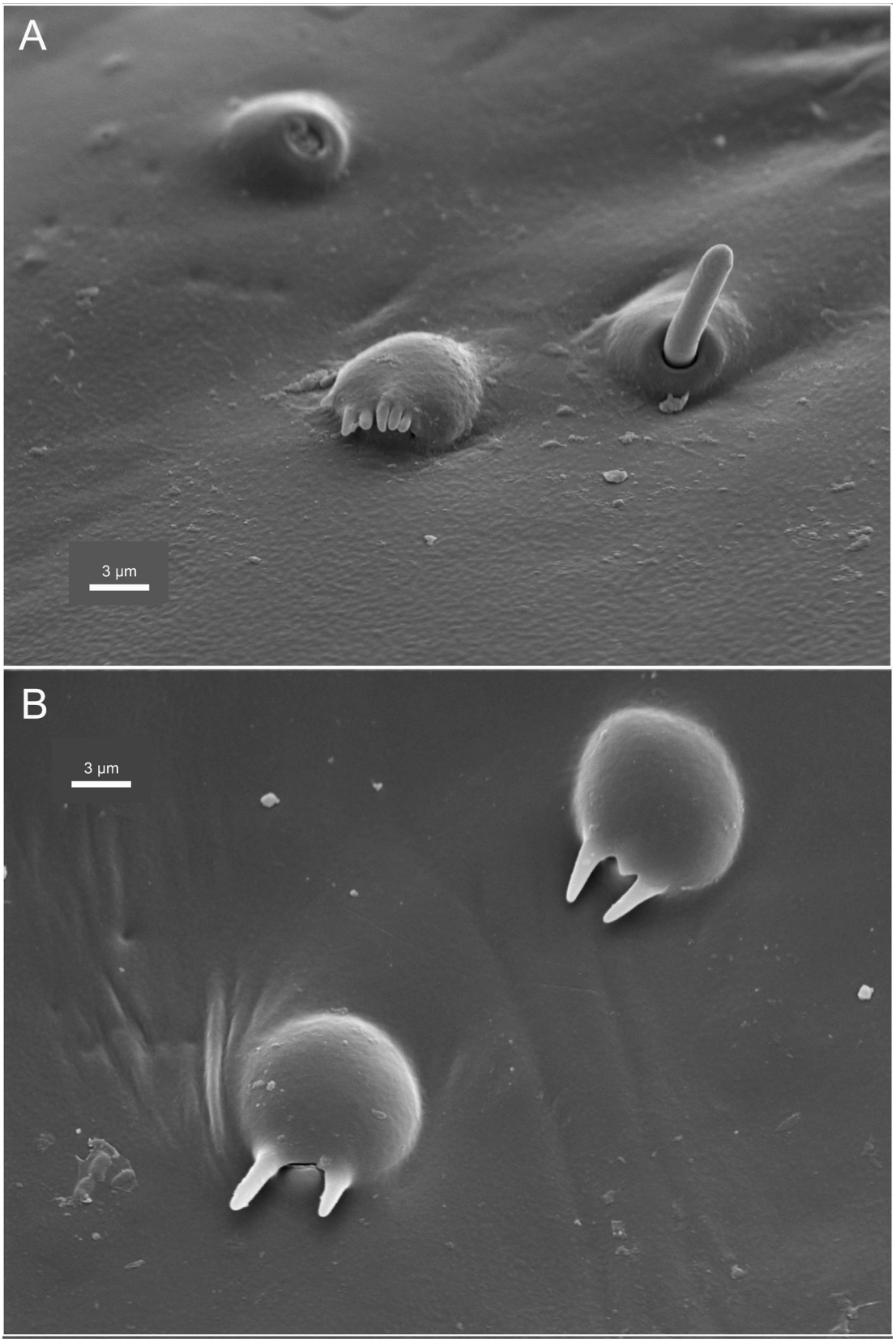


Plate fig. 37. Integumental glands in two different species of the New Zealand genus *Xenophyes*. A – *X. cascus*. B – *X. rhachilophus*. Note the different sizes and numbers of peripheral elements in the two species.

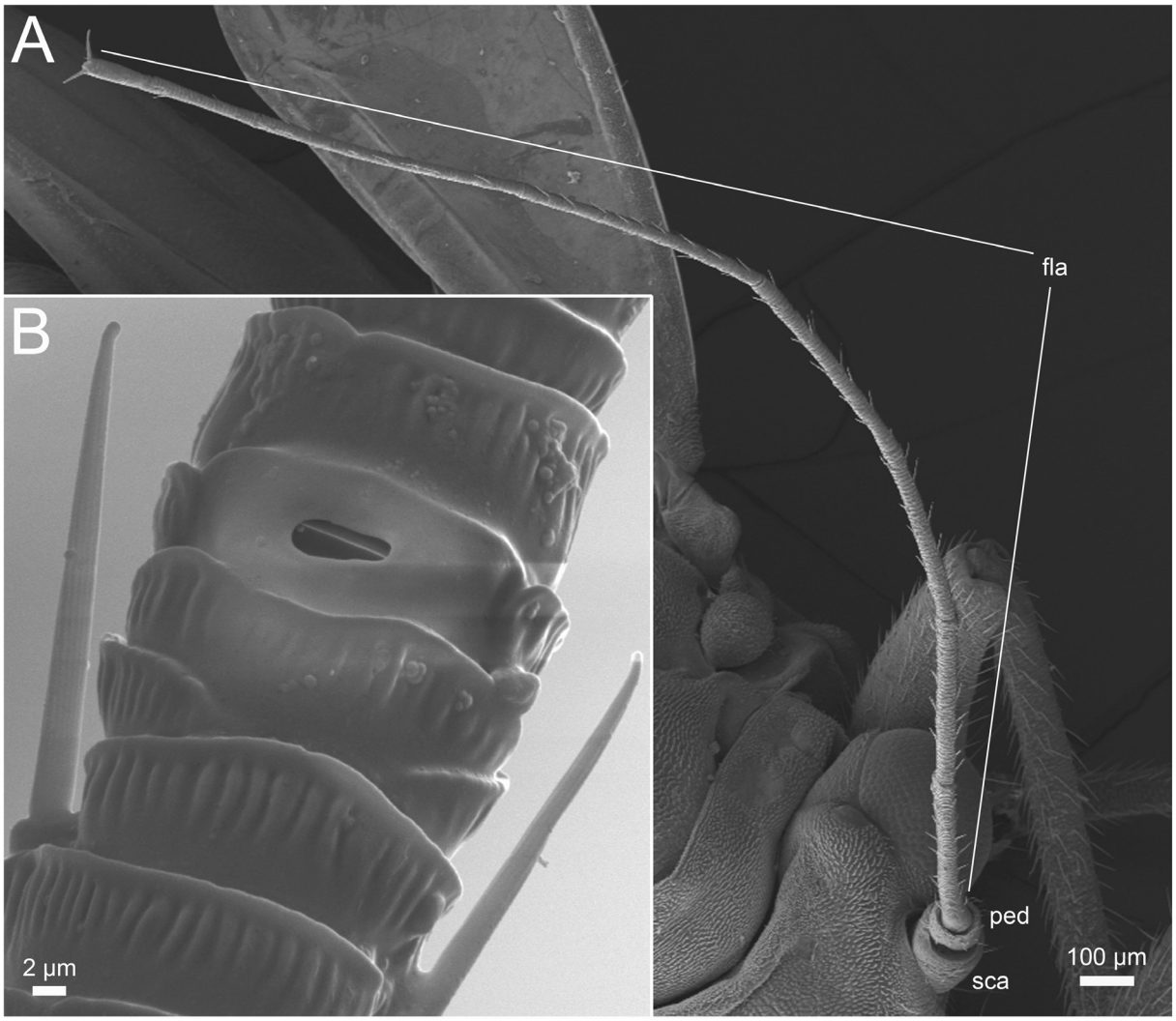


Plate fig. 38. Left antenna of *Psylla alni* and its sensilla. A – general view; fla = flagellum, ped = pedicel, sca = scape. B – distal end of the 6th flagellomere, with two of the socketed sensilla and a coeloconic one.

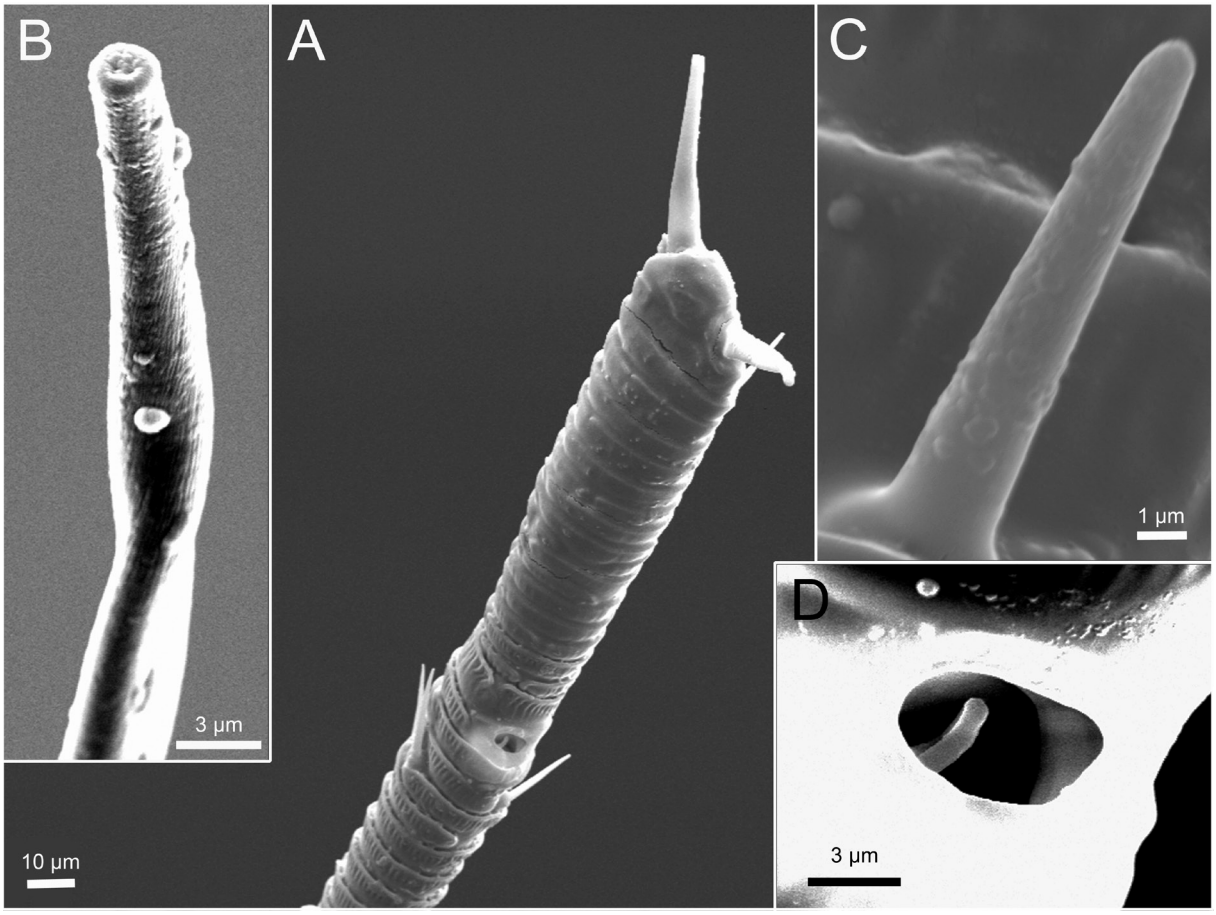


Plate fig. 39. Sensilla on the left antenna of *Psylla alni*. A – general view of the distal end of the flagellum. B – apical seta. C – non-socketed basiconic sensilla, 7th flagellomere. D – coeloconic sensillum on the distal end of the 7th flagellomere.

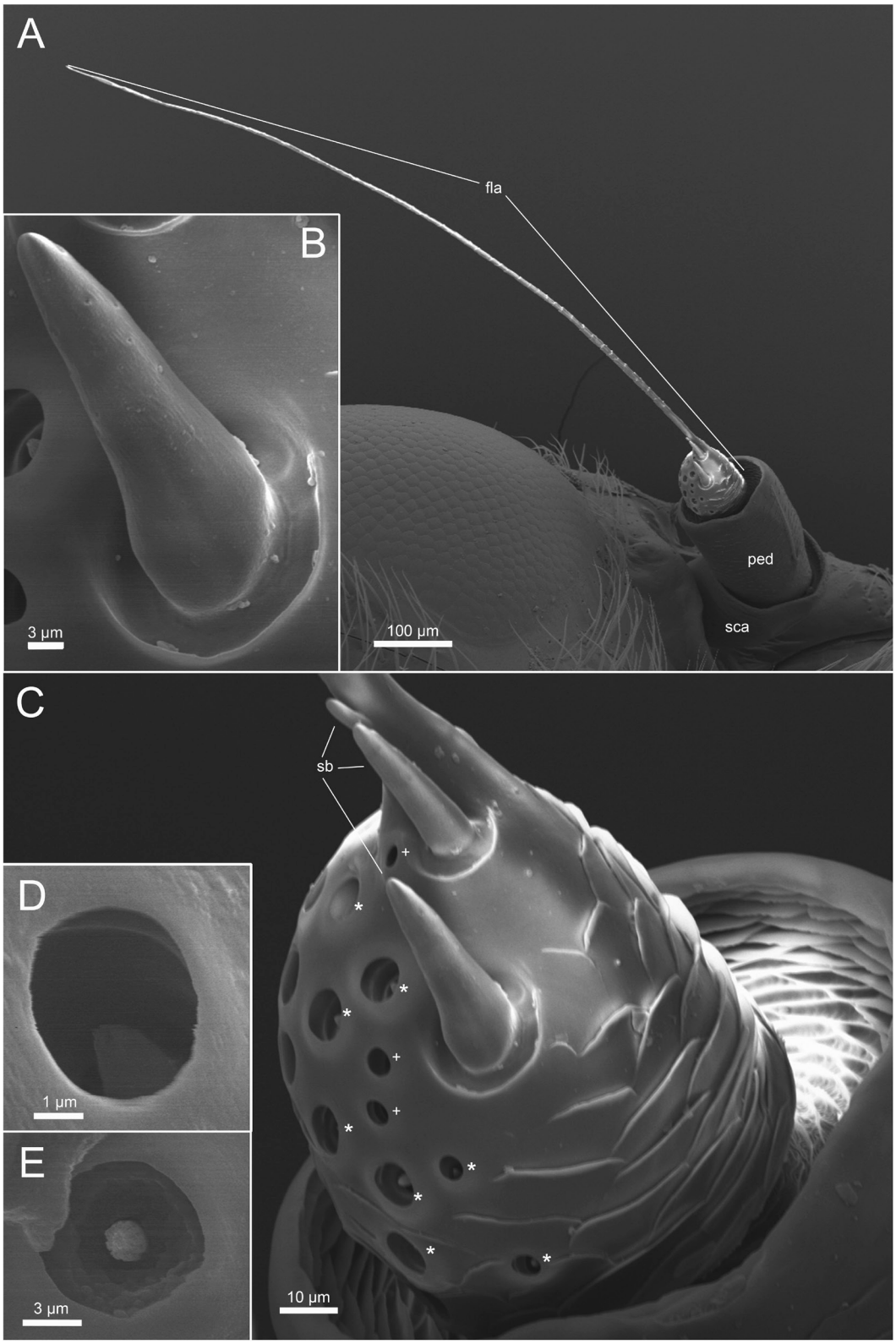


Plate fig. 40. Right antenna of *Cercopis sanguinolenta*. A – general view; fla = flagellum, ped = pedicel, sca = scape. B – one of the sensilla basiconica; note the finely porose surface. C – sensilla on the flagellar base; sb = sensilla basiconica. Asterisks denote the double-walled coeloconic sensilla, pluses the single-walled. D – close-up of a single-walled coeloconic sensillum. E – close-up of a double-walled coeloconic sensillum.

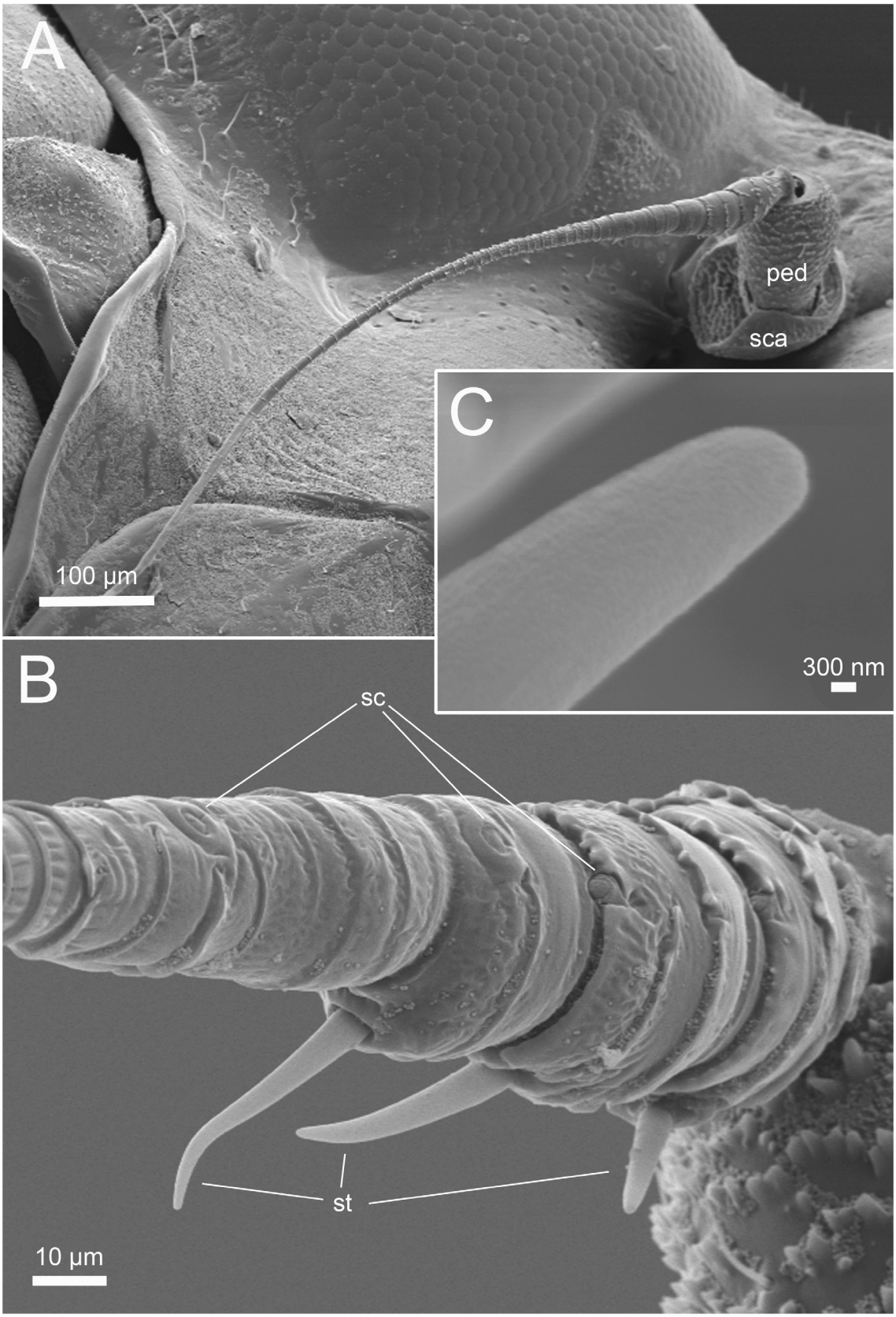


Plate fig. 41. Right antenna of *Cicadella viridis*. A – general view; ped = pedicel, sca = scape. B – base of the flagellum with segment borders; sc = sensilla campaniformia, st = sensilla trichodea. C – tip of the basalmost sensillum trichodeum; note the finely porose surface.

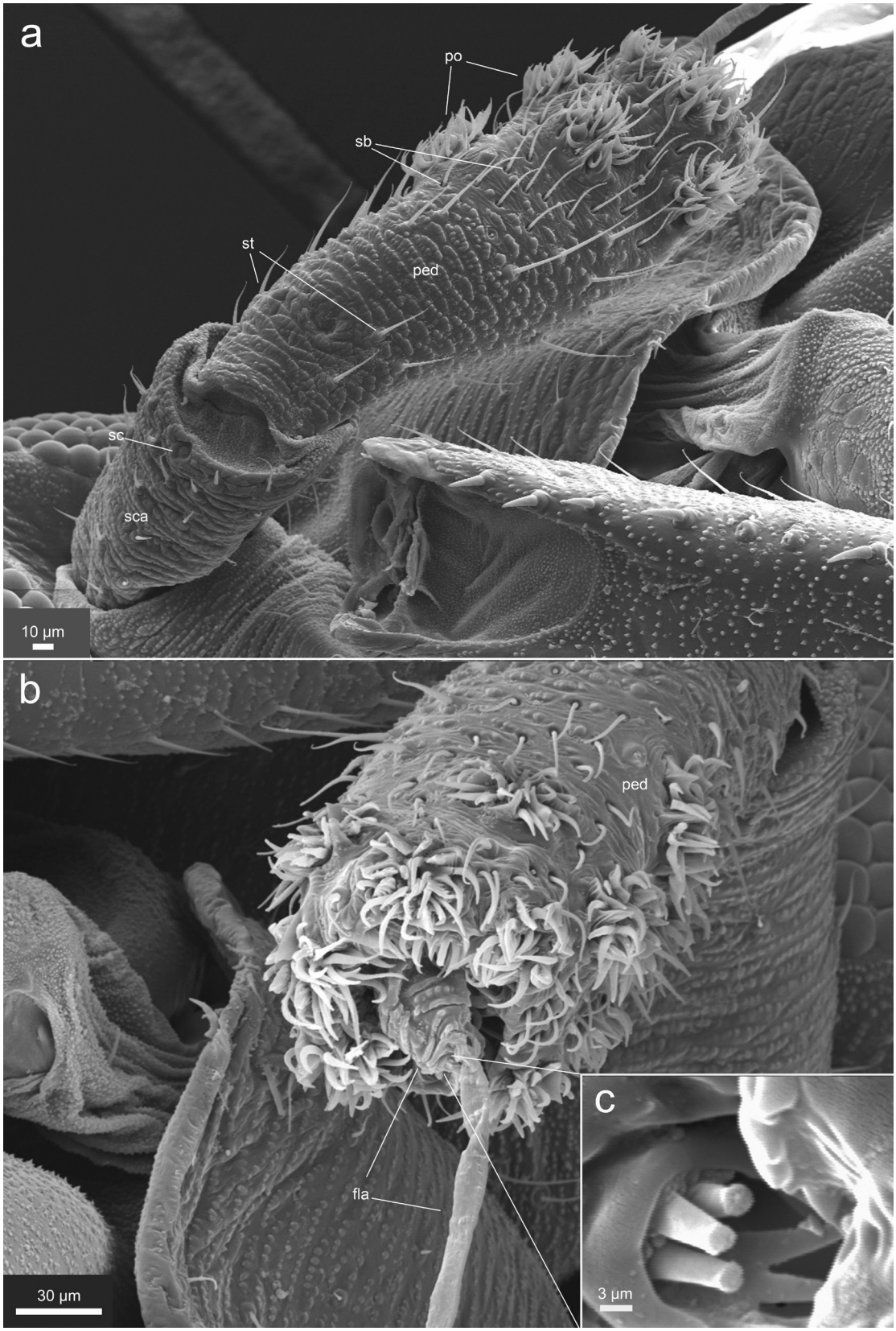


Plate fig. 42. Left antenna of *Laodelphax striatella*. a – general view; ped = pedicel, po = plaque organs, sb = sensilla basiconica, sc = sensillum campaniformium, st = sensilla trichodea; b – distal region of the pedicel and basal region of the flagellum; fla = flagellum, ped = pedicel; c – basiconic sensilla from b.

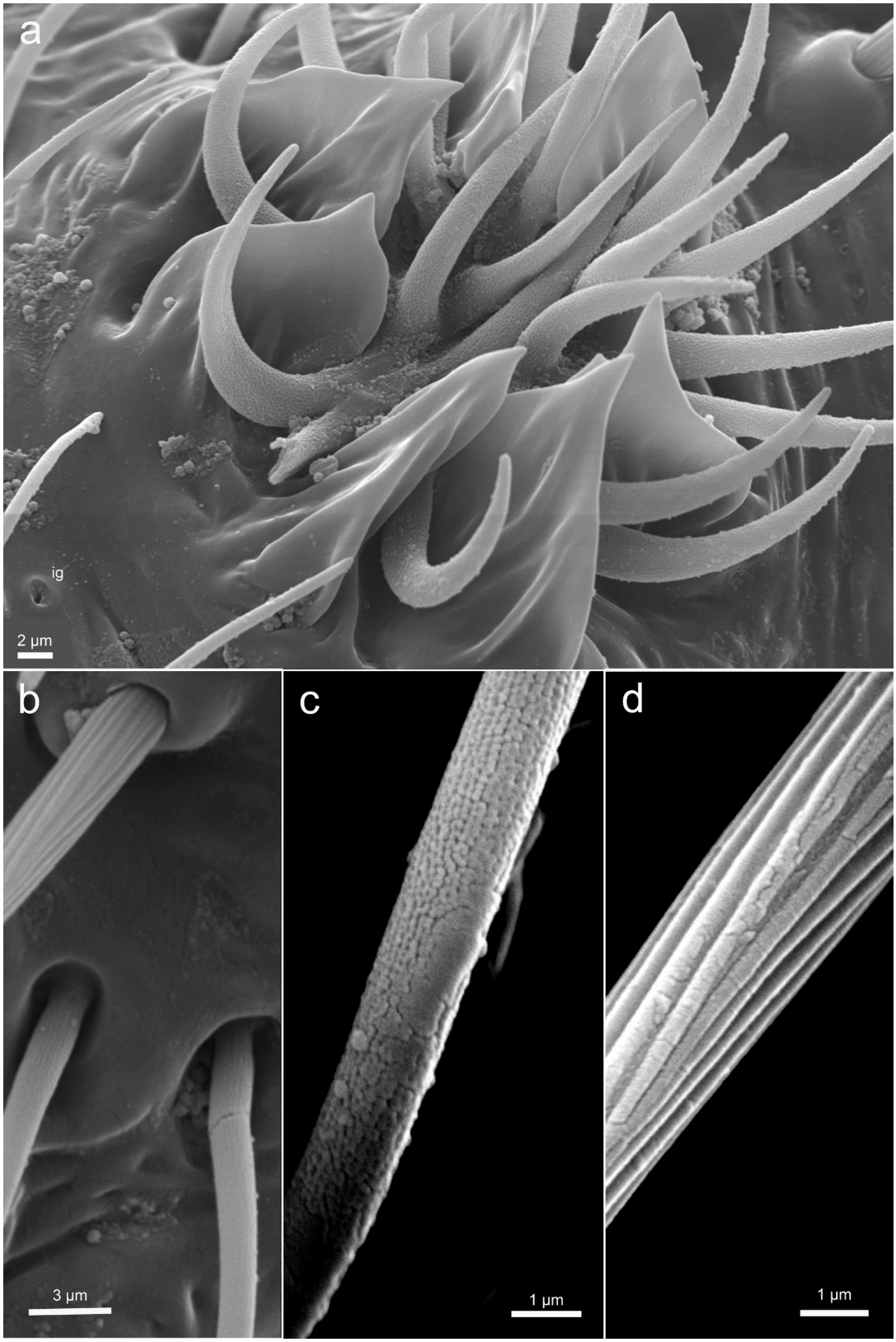


Plate fig. 43. Details of antennal sensory structures of *Laodelphax striatella*. a – a plaque organ, with some neighbouring basiconic sensilla; ig = integumental gland; b – basal regions of one sensillum trichodeum (above) and two sensilla basiconica (below); c – fine surface structure of a basiconic sensillum; d – fine surface structure of a trichoid sensillum.

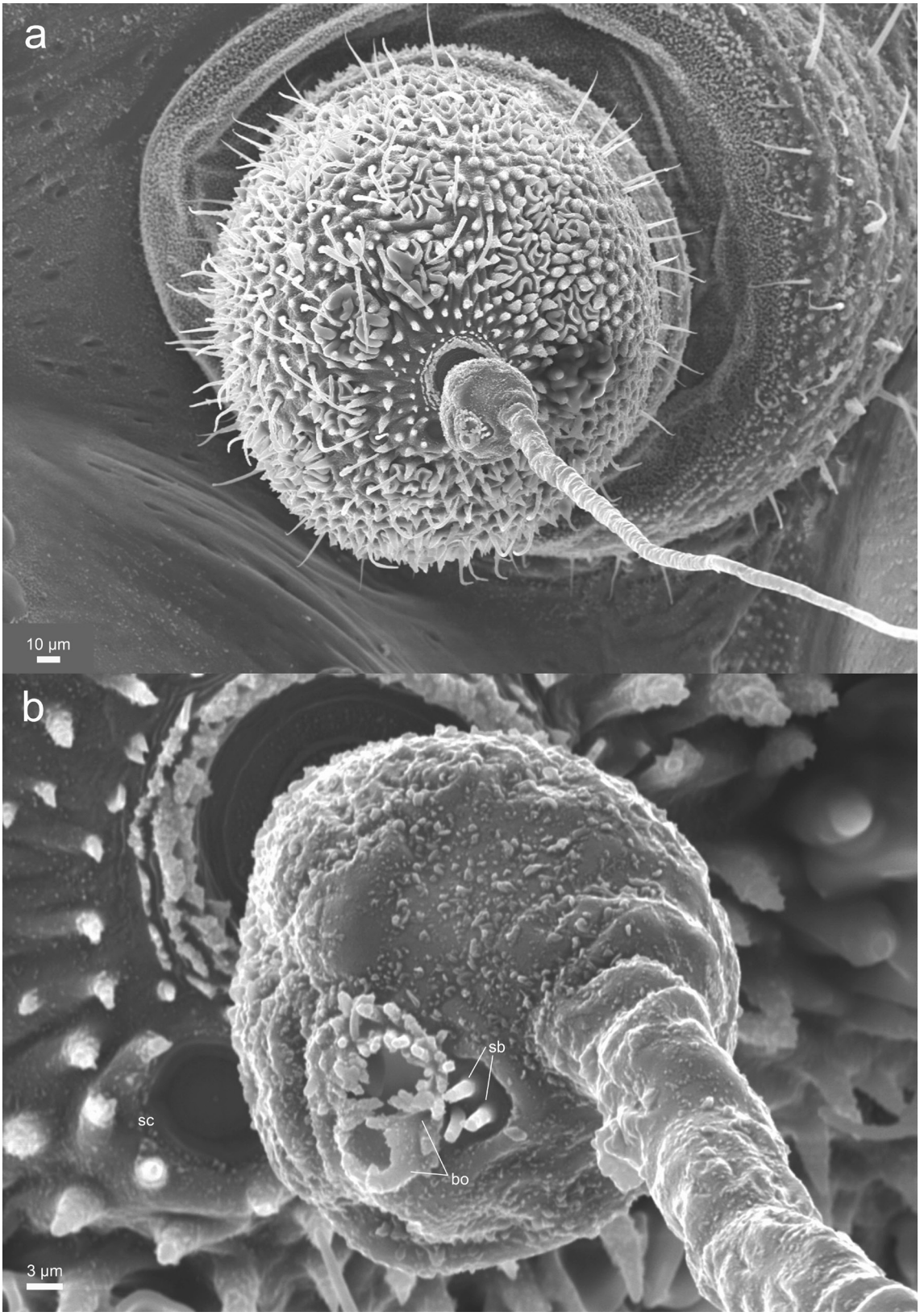


Plate fig. 44. Right antenna of *Issus coleoptratus*. a – distal view of pedicel and flagellum; b – base of the flagellum; bo = Bourgoin's organ, sb = sensilla basiconica, sc = sensillum campaniformium.

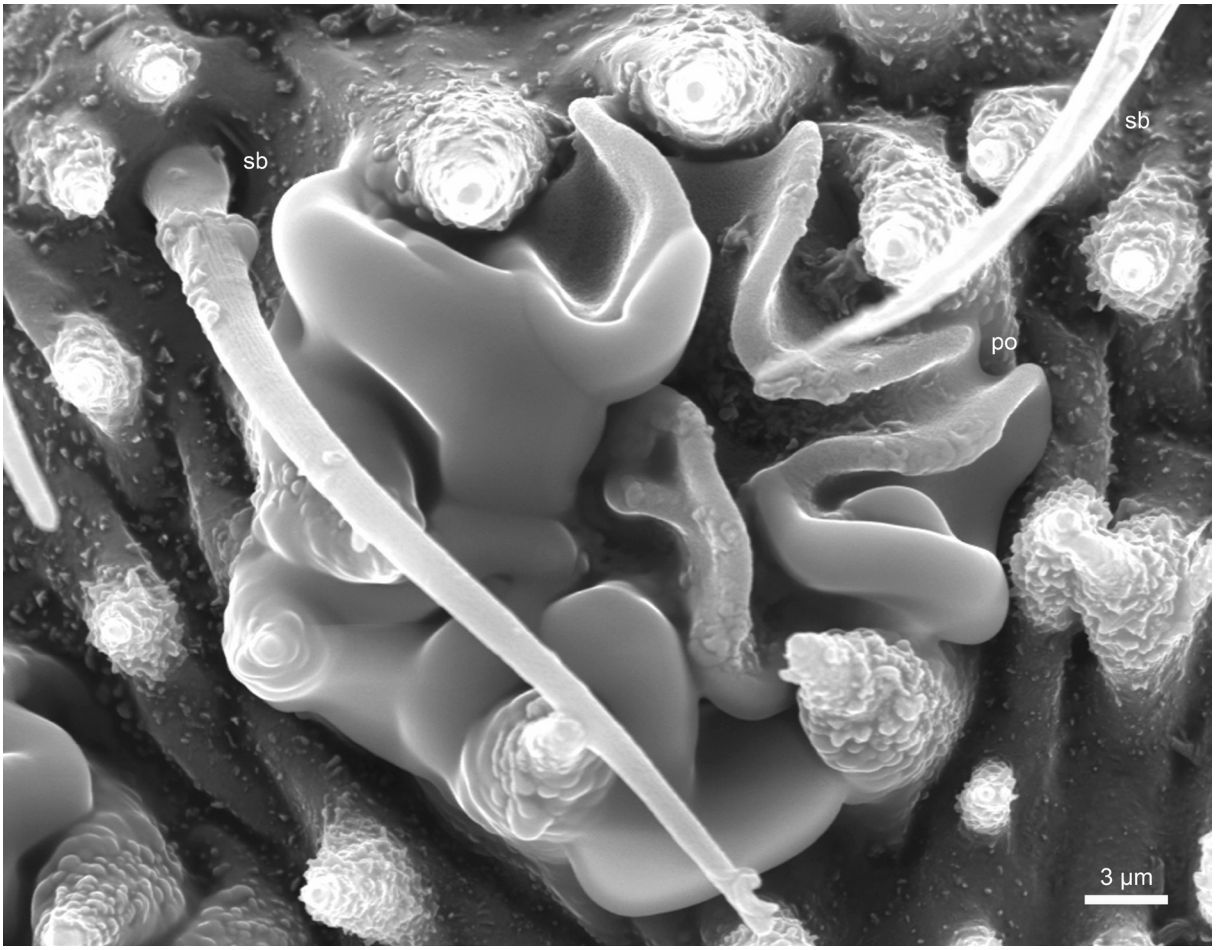


Plate fig. 45. A plaque organ on the pedicel of *Issus coleoptratus*. The large plaque organ (po) is in the center; most of it is covered by some secretion, obscuring the fine porous surface structure. Two sensilla basiconica (sb) with finely porose surface are also seen.

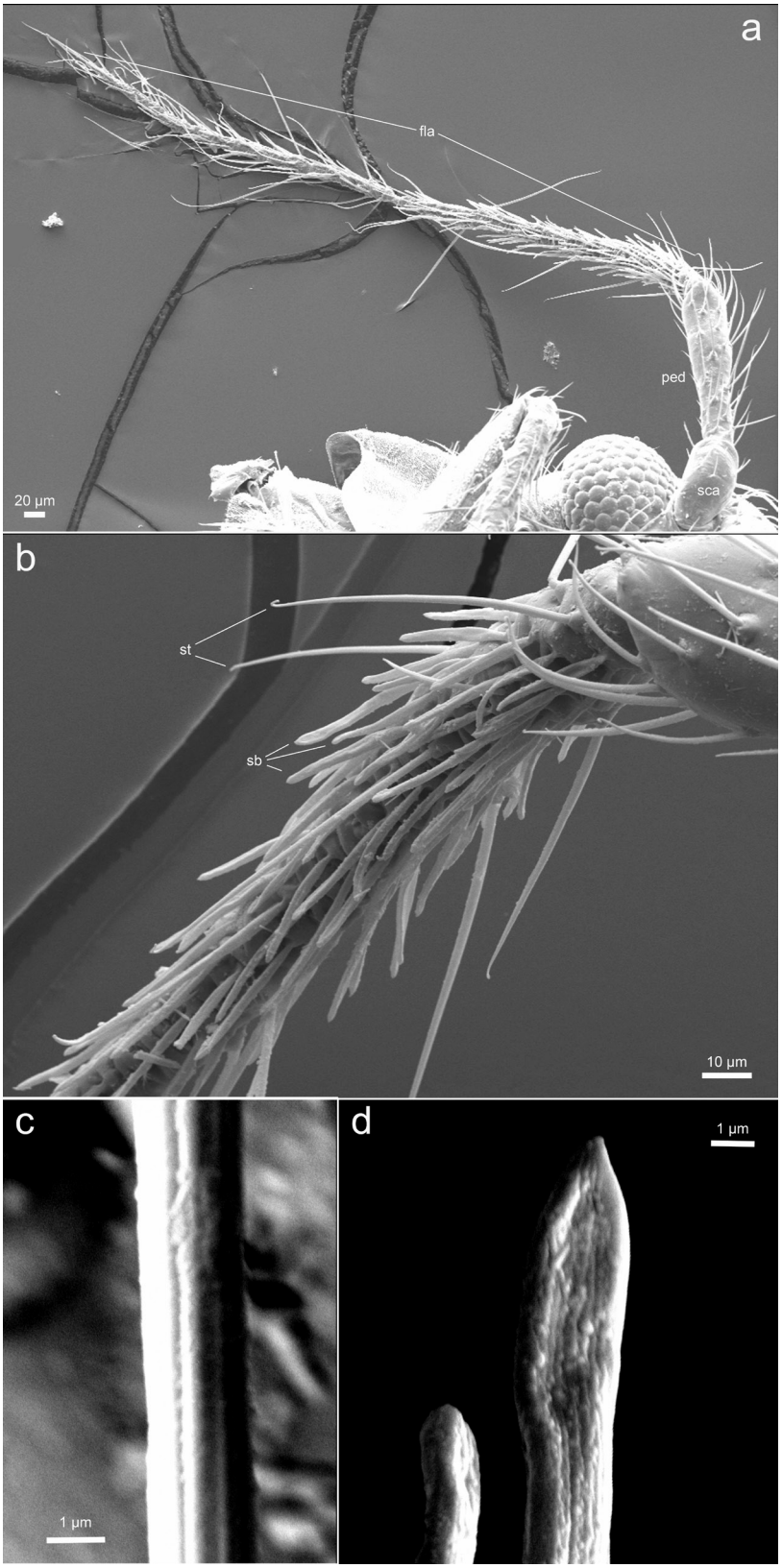


Plate fig. 46. Antenna of *Ceratocombus* sp. a – general view; fla = flagellum, ped = pedicel, sca = scape. b – two sensilla types on the flagellomeres; sb = sensilla basiconica, st = sensilla trichodea. c – surface detail of a sensillum trichodeum; note the deep grooves. d – surface detail of a sensillum basiconicum; not the numerous fine grooves and pores.

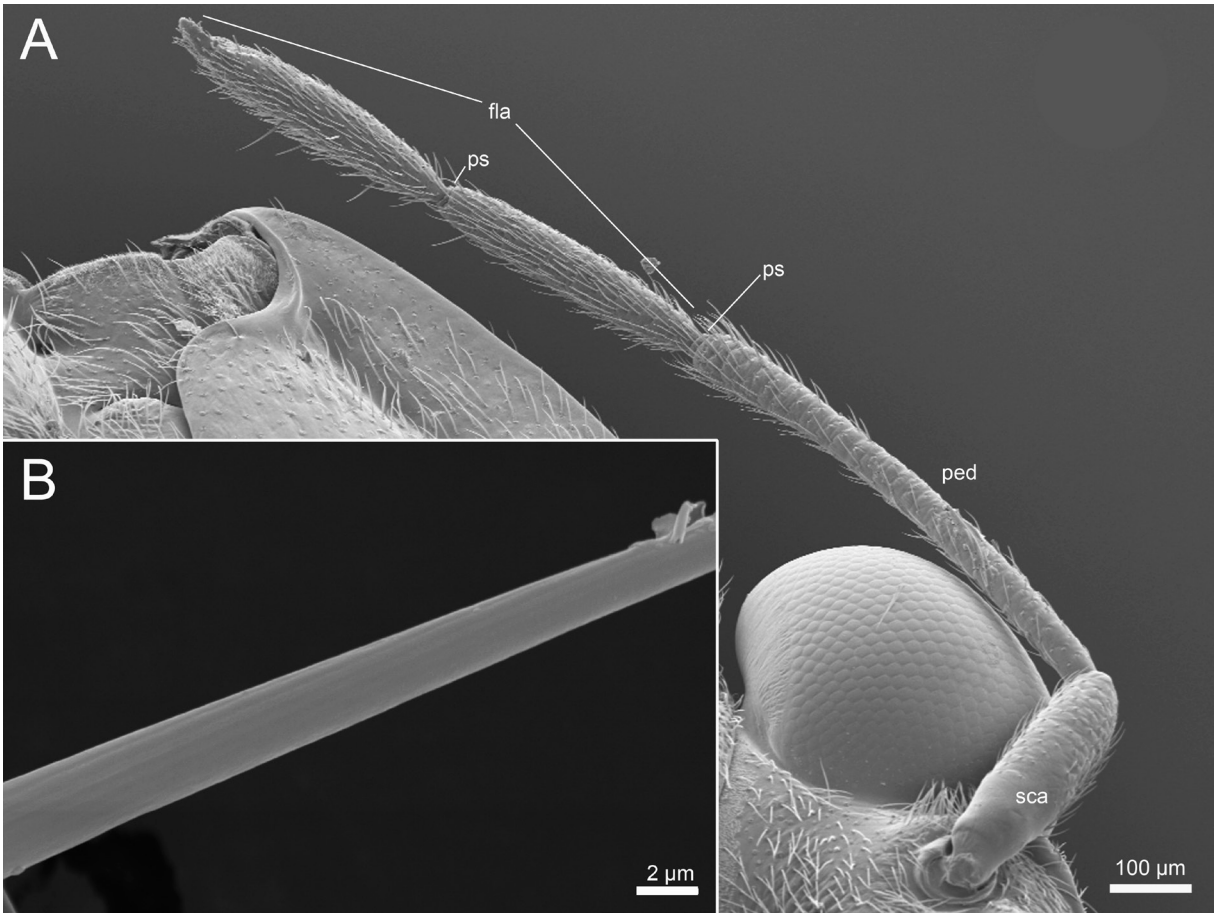


Plate fig. 47. Antenna of *Saldula saltatoria*. A – general view; fla = flagellum, ped = pedicel, ps = pre-segment; sca = scape. B – detail view of the surface of a flagellar trichoid erect sensillum.

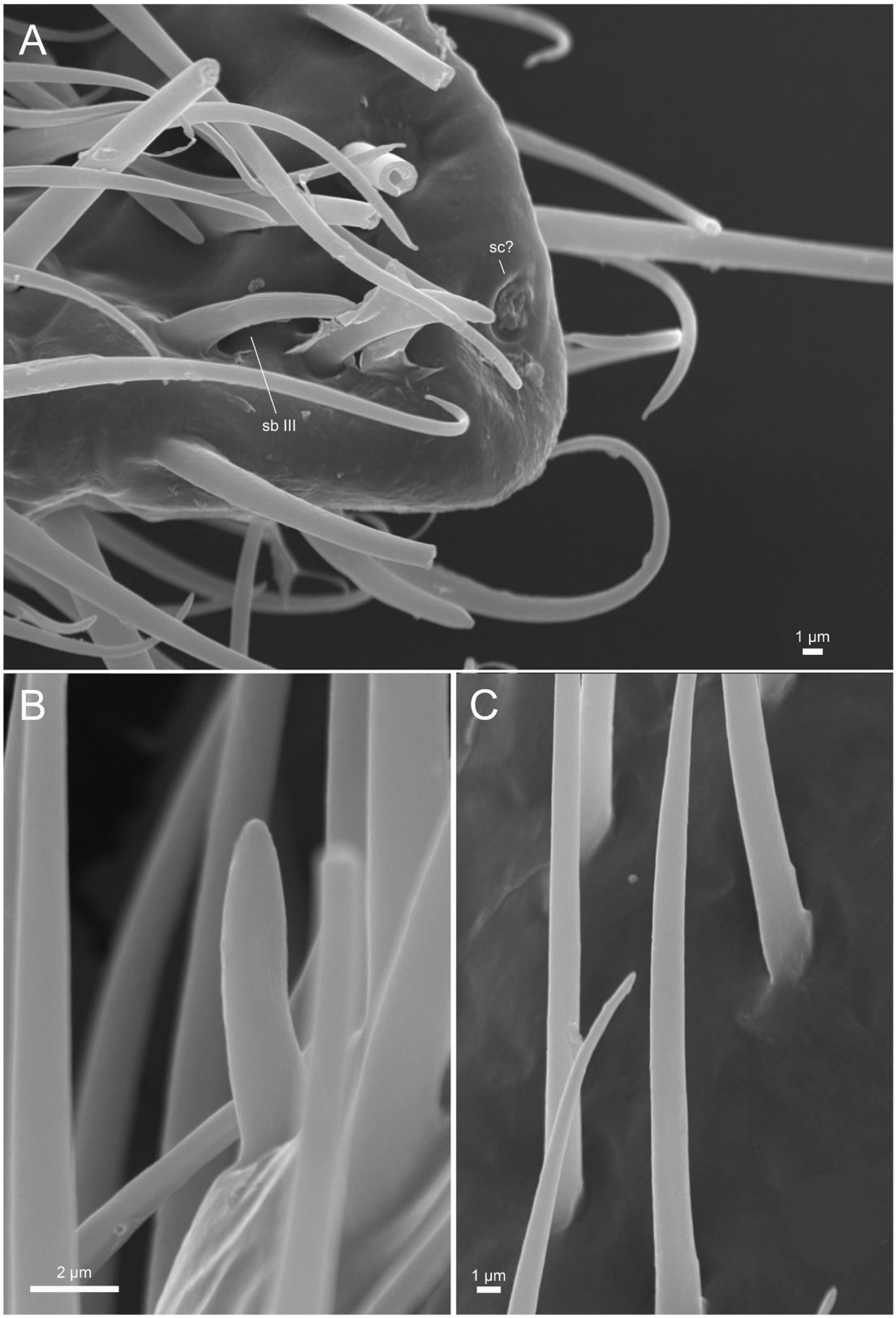


Plate fig. 48. Antennal sensilla of *Saldula saltatoria*. A – the very tip of the terminal flagellomere; sb III = sensillum basiconicum type 3 (olfactory); sc? = sencillum coeloconicum (presumably). B – sensillum basiconicum type 2; note the small size and the smooth surface. C – several sensilla basiconica type 1; note their smooth surface.

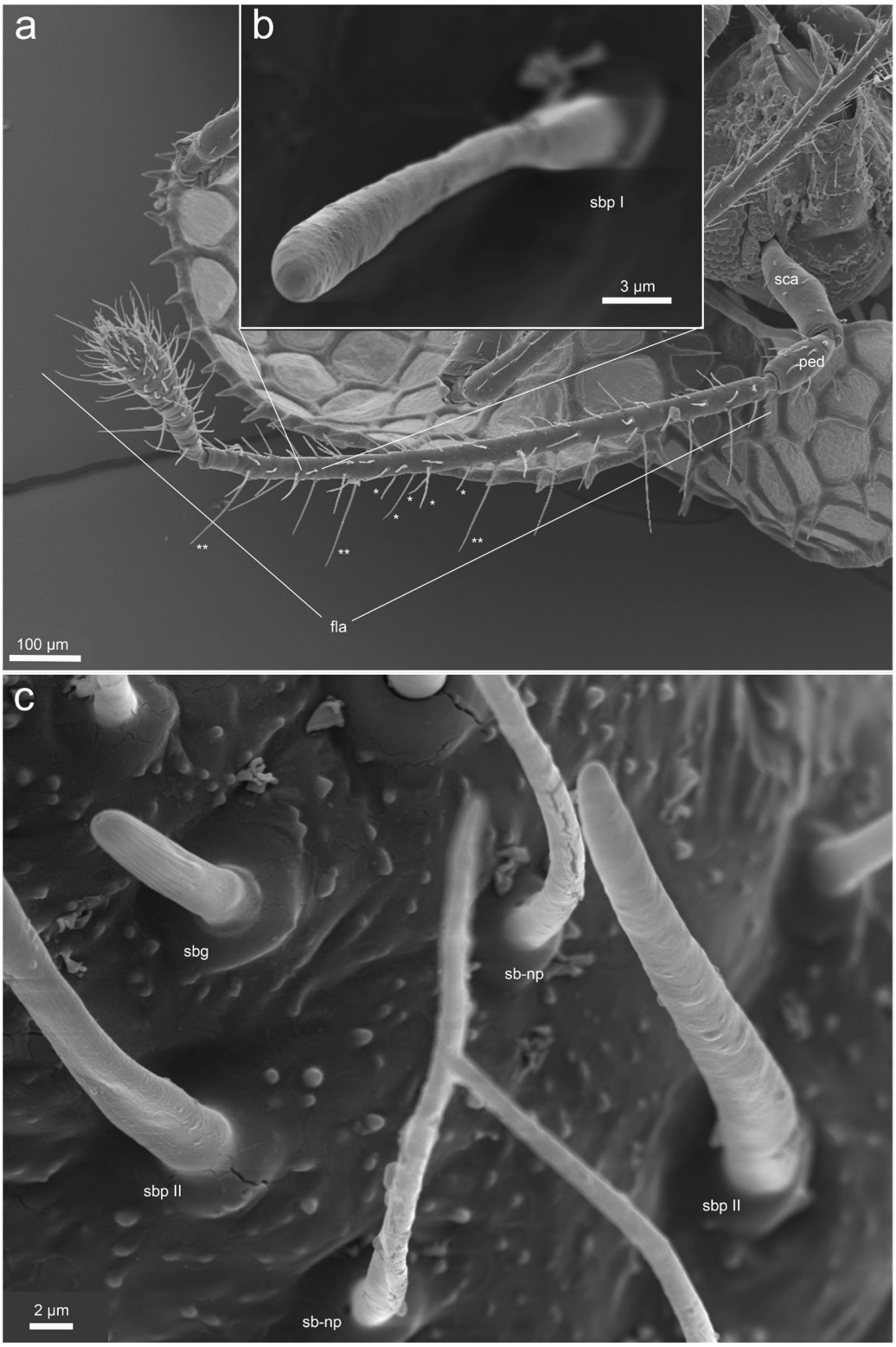


Plate fig. 49. Antenna and sensilla of *Corythucha ciliata*. a – general view; fla = flagellum, ped = pedicel, sca = scape; asterisks denote short trichoid sensilla, double asterisks – long trichoid sensilla. b – close-up of a non-socketed basiconic sensilla with porose surface type I; sbp I = sensilla basiconica porose I. c – details of several non-socketed basiconic sensilla of the terminal flagellomere; sbg = sensilla basiconica, grooved, sb-np = sensilla basiconica, non-porose; sbp II = sensilla basiconica with porose surface type II.

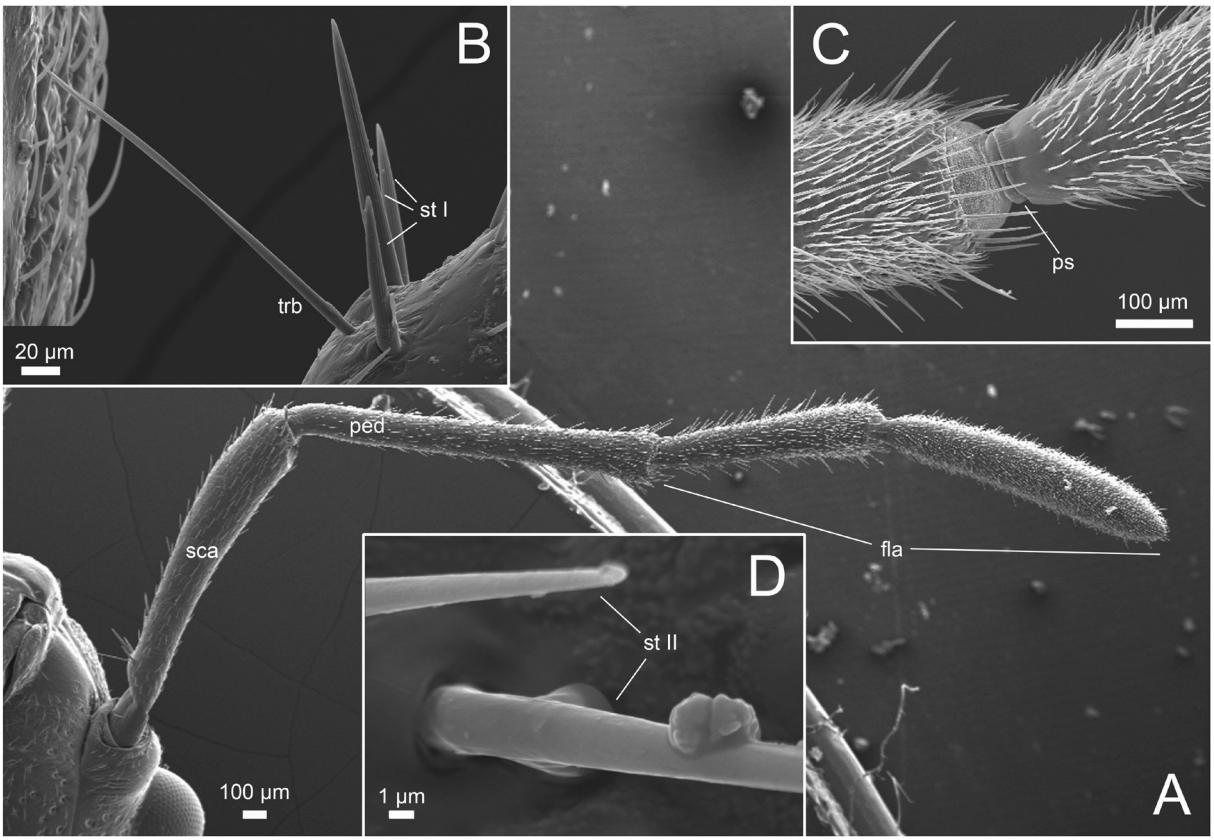


Plate fig. 50. Antenna of *Pyrrhocoris apterus*. A – general view; fla = flagellum, ped = pedicel, sca = scape. B – base of the scape with trichobothrium (trb) and long sensilla trichoidea (st I). C – border between the first and the second flagellomere; ps = pre-segment. D – structure details of another sensilla trichodea type (st II), first flagellomere.

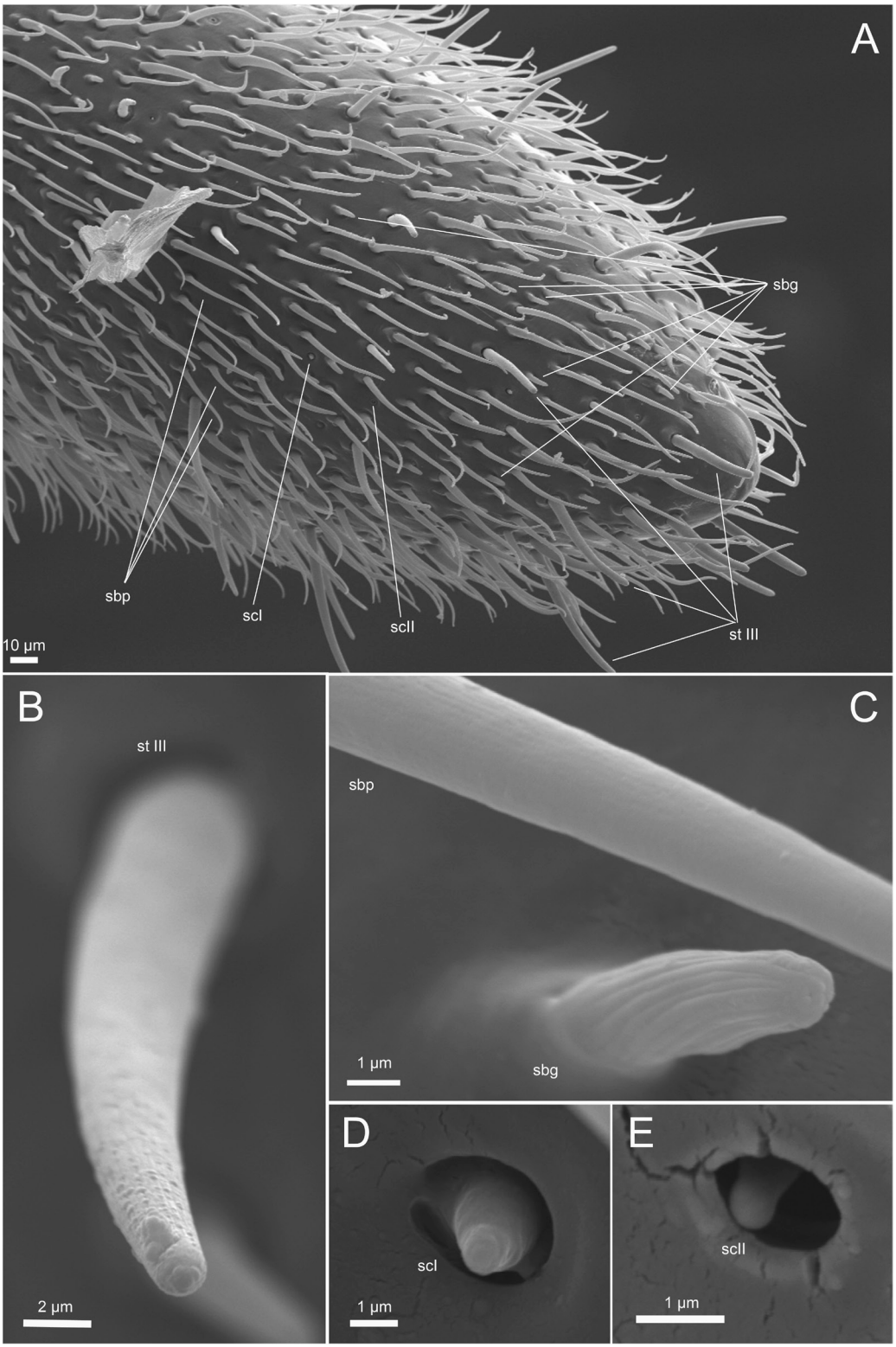


Plate fig. 51. Antennal sensilla on the terminal flagellomere of *Pyrrhocoris apterus*. A – distal part of the flagellomere; sbg = sensilla basiconica, grooved; sbpI = sensilla basiconica type I; sbpII = sensilla basiconica type II; scI = sensilla coeloconica type I; scII = sensilla coeloconica type II. B - close-up of a sensillum basiconicum type II; note the finely porose surface. C – close-up of a sensillum basiconicum type I (upper part, fragment; note the finely porose surface) and a grooved sensillum basiconicum. D – sensillum coeloconicum type I. E – sensillum coeloconicum type II.

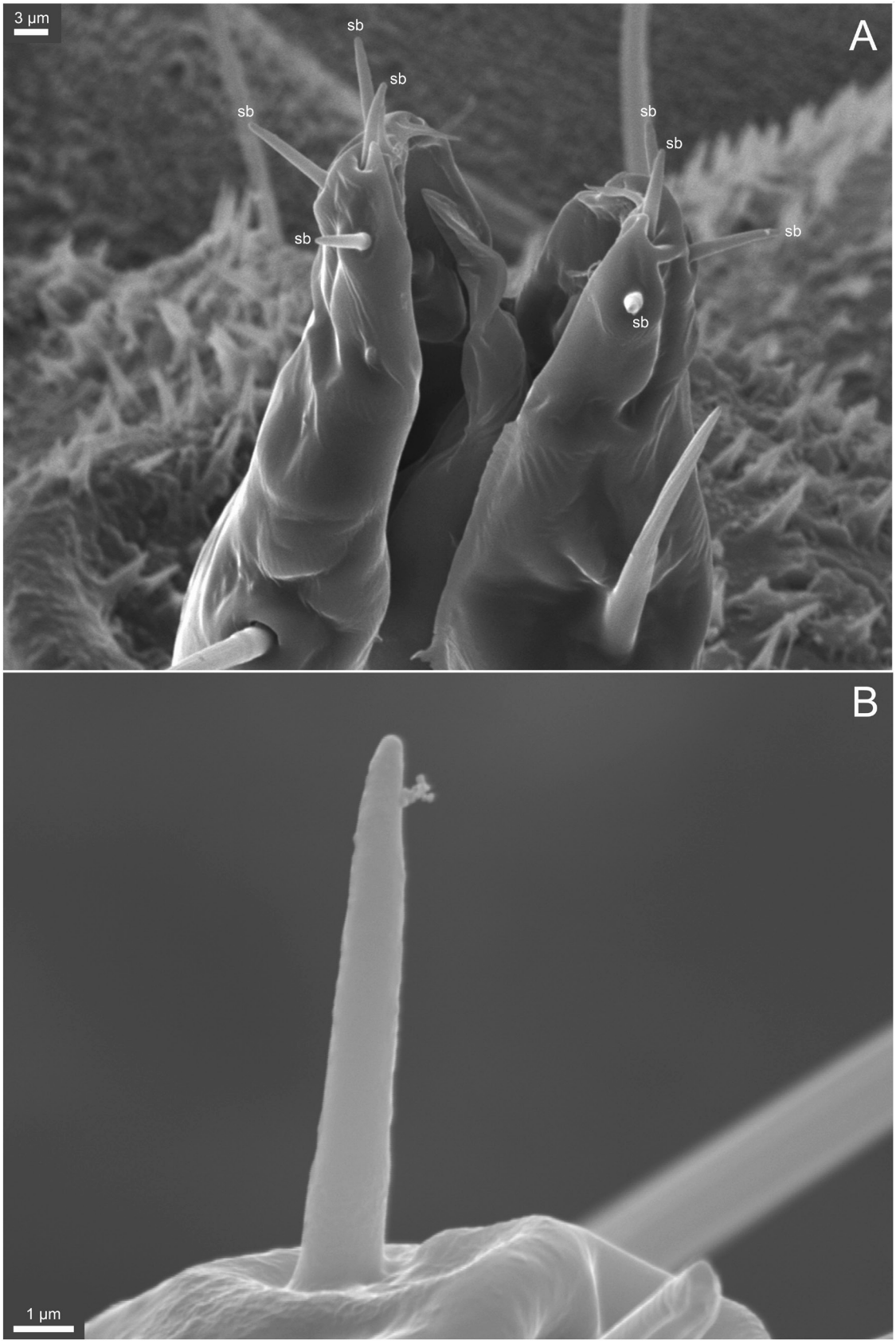


Plate fig. 52. Labium tip and sensilla of *Psylla alni*. A – terminal labial segment, sutural view; sb = sensilla basiconica. B – one of the sensilla basiconica, magnified; note its smooth surface.

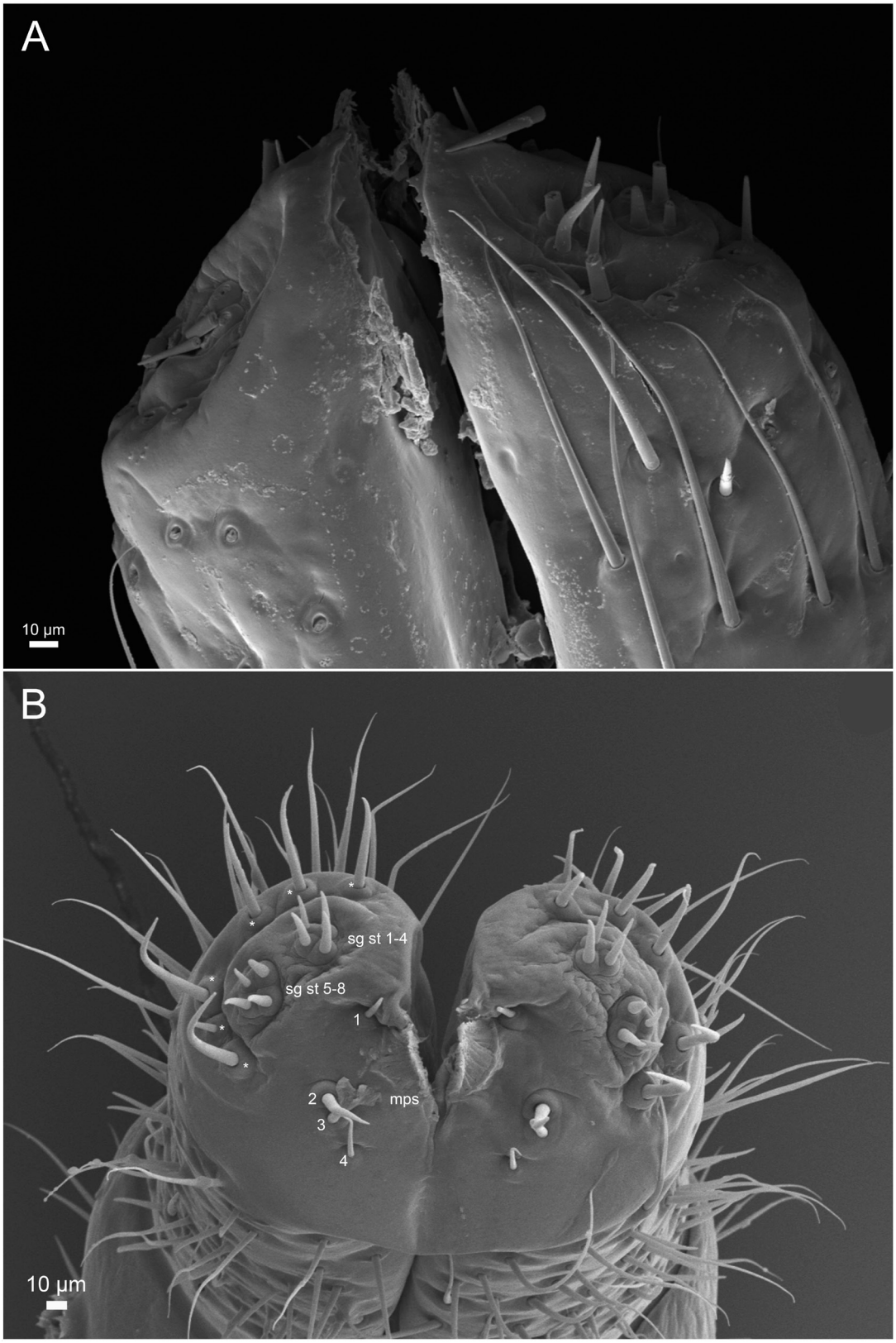


Plate fig. 53. Labium tip and sensilla of *Cercopis sanguinolenta*. A – sutural view. B – caudal view (another specimen); inner sensilla are numbered from sutural to antisutural side; mps = multi-peg structure; sg st 1-4 and 5-8 = sutural group sensilla trichodea 1-4 and 5-8; asterisks denote the peripheral circle of the sensilla.

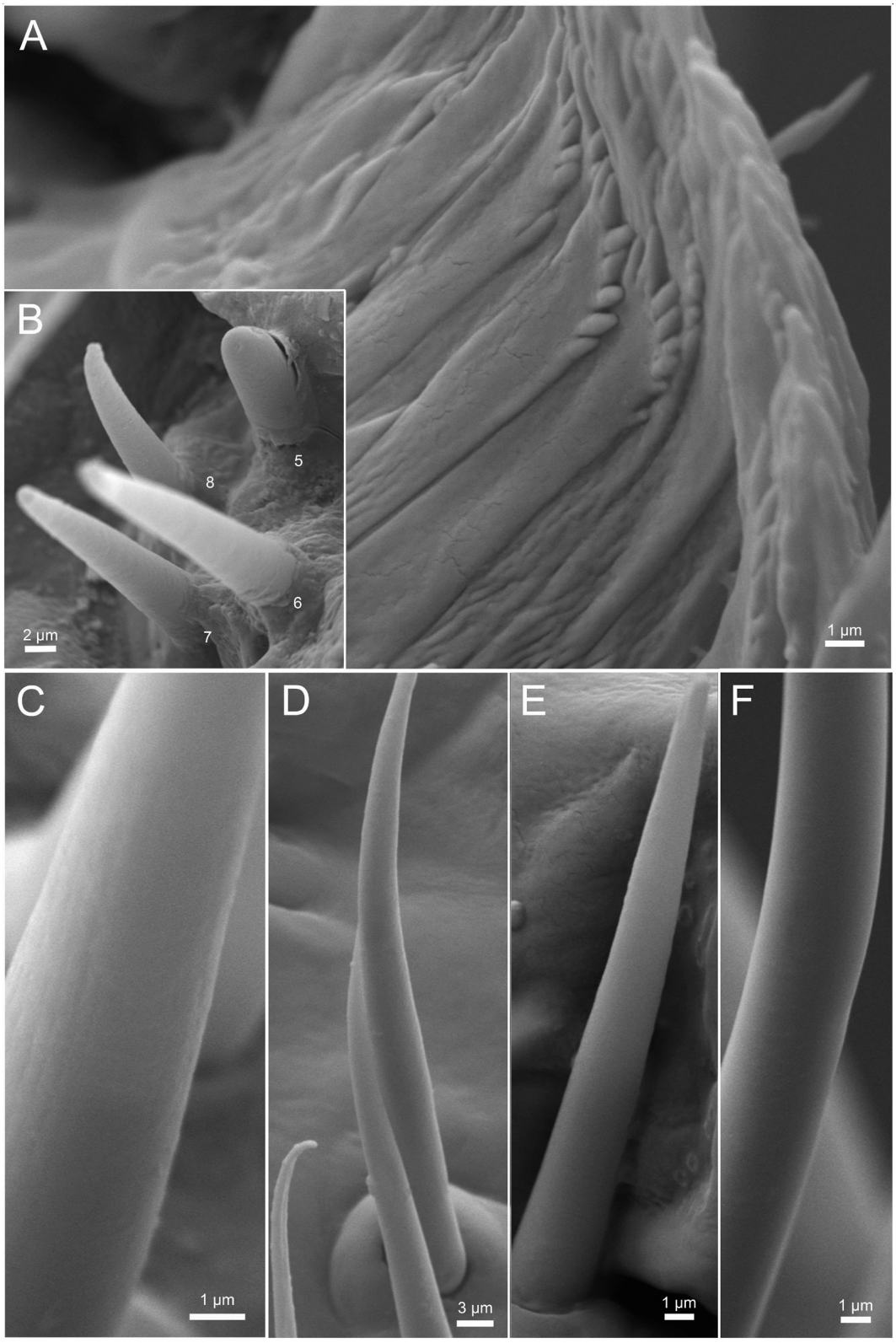


Plate fig. 54. Structures and sensilla of the labium tip in *Cercopis sanguinolenta*. A – multi-peg structure, built by several tightly packed scales. B – sensilla 5-8 of the sutural group: note the blunt tip and clearly visible pores on it in the sensillum 5. C – one of the sharp-tipped sensilla of the group 5-8; note the porous surface. D – inner trichoid sensilla 2 and 3. E – inner trichoid sensillum 1. F – one of the peripheral circle of the trichoid sensilla. Note the smooth surface of the sensilla in C-E.

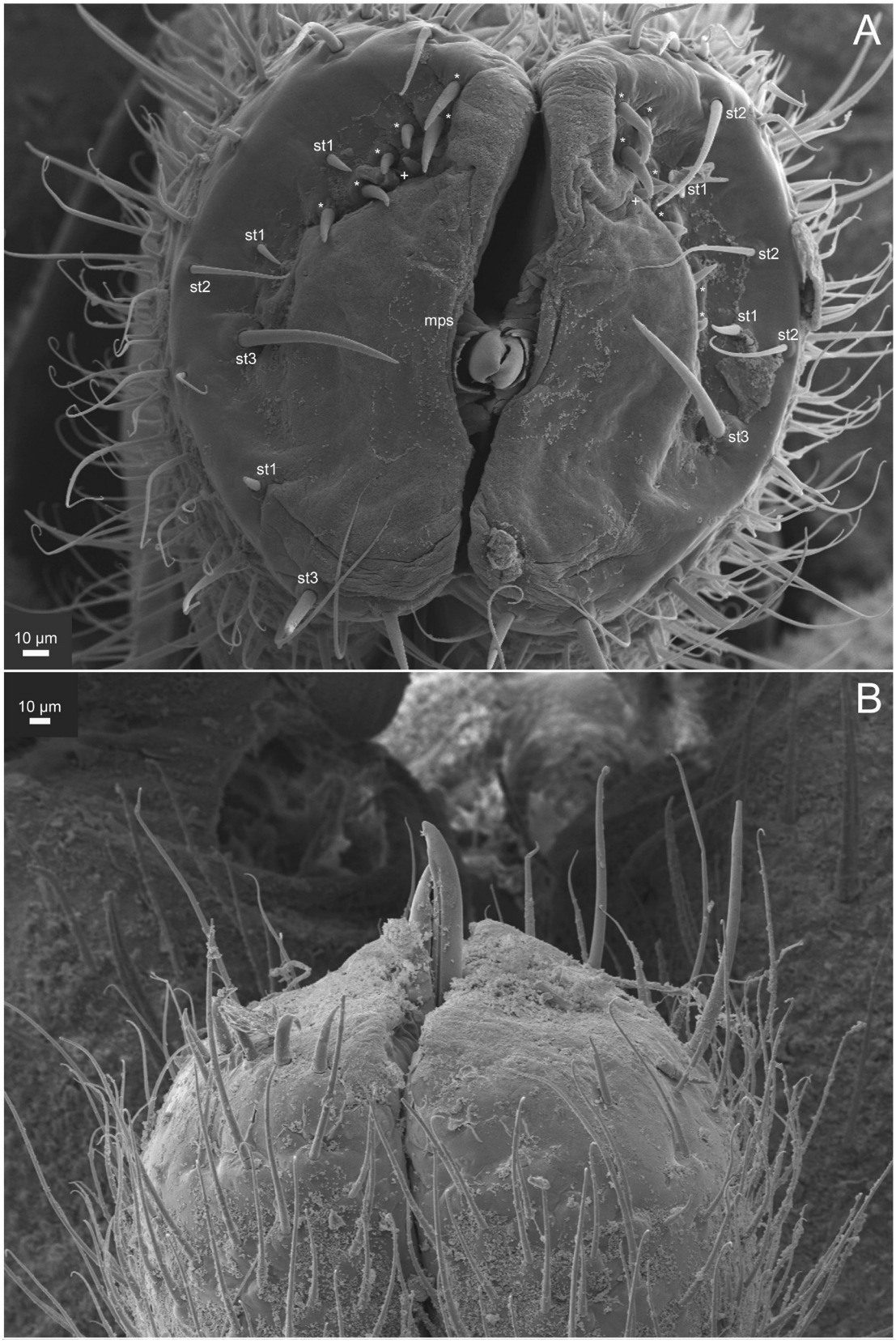


Plate fig. 55. Labium tip and sensilla of *Cicadella viridis*. A – caudal view; mps = multi-peg structure, st1, 2, 3 = sensilla trichodea 1, 2, 3; "*" denotes sensilla basiconica 1, "+" – sensilla basiconica 2. B – sutural view (different specimen).

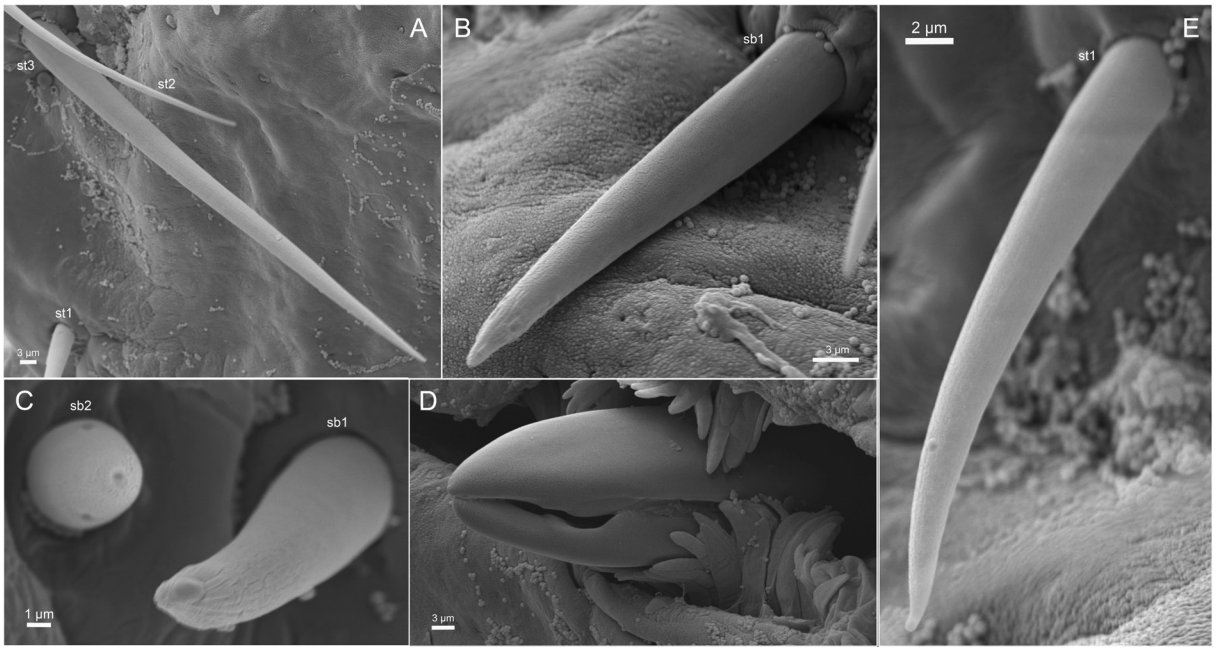


Plate fig. 56. Sensilla of the labium tip in *Cicadella viridis*. A – sensillum trichodeum of the largest type (st3), with two others partly visible; note the moulting pore on the base of st3. B – sensillum basiconicum 1, note the irregular form of the tip and smooth surface. C – sensilla basiconica of the type 1 and 2; note three pores (one terminal and two basal) visible on the sb2. D – stylets protruding between the multi-peg structure. E – sensillum trichodeum 1.

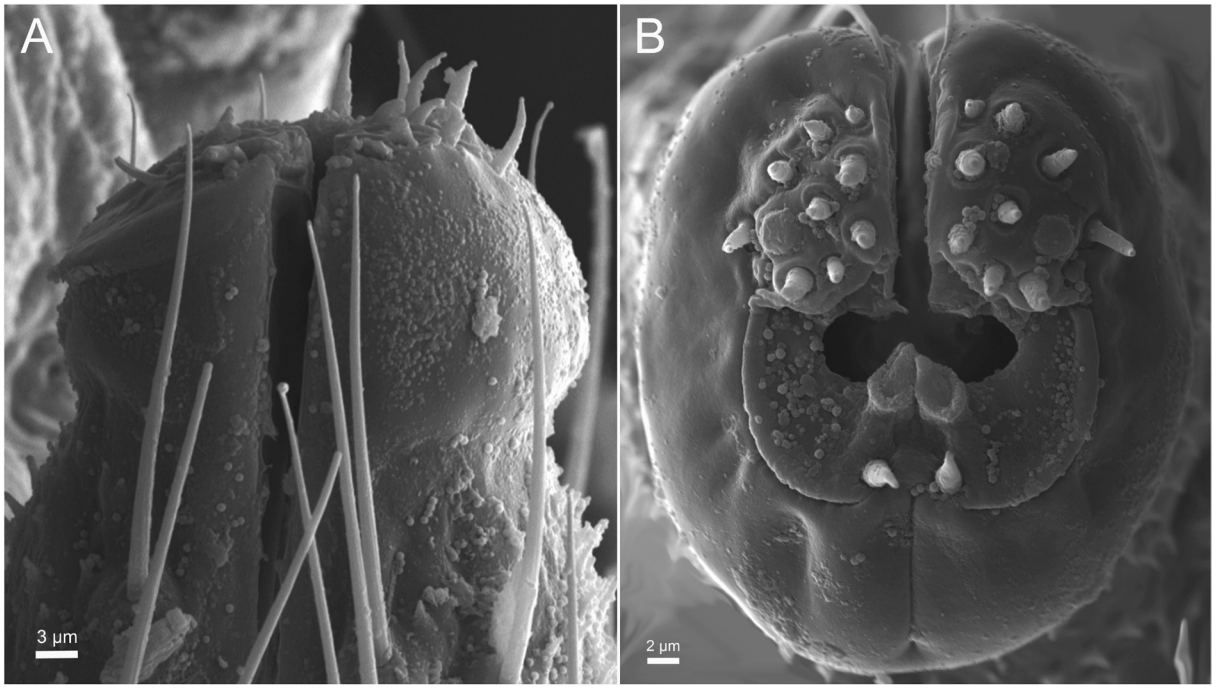


Plate fig. 57. Labium tip of *Laodelphax striatella*. A – sutural view, B – caudal view.

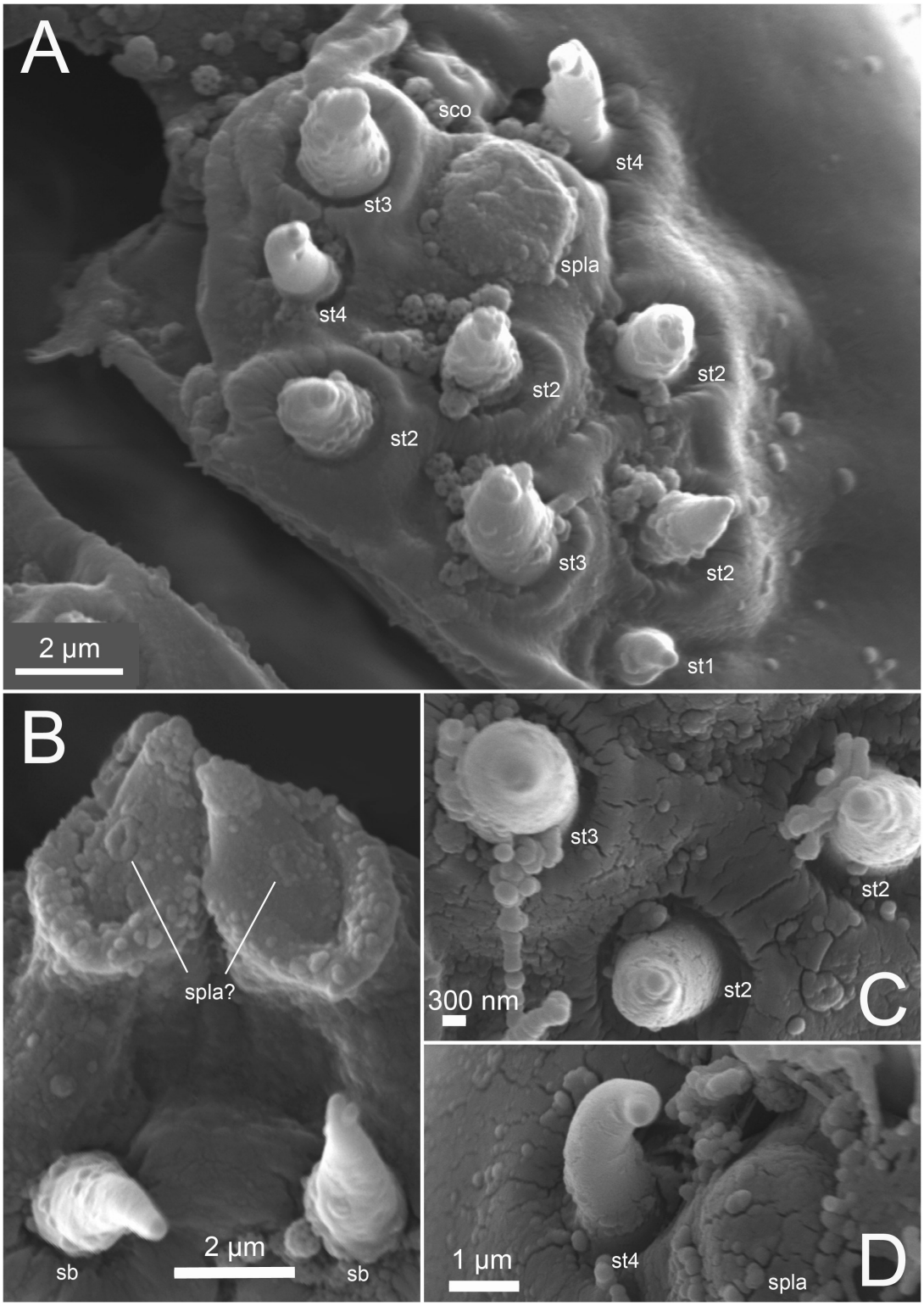


Plate fig. 58. Sensilla on the labium tip of *Laodelphax striatella*. A – general view of the sutural group; sco = sensillum coeloconicum, spla = sensillum placodeum, st1-4 = sensilla trichodea of the type 1-4, respectively. B – sensillum basiconicum (sb) and the triangular process with a sensillum placodeum (spla?) on the antisutural margin of the labium orifice. C – sensilla trichodea of the types 2 and 3 from A, magnified; note the complicated tip structure in st2 (pore complex?) and a simple pore on the tip in st 3. D – st4, magnified; note the thin twisted tip.

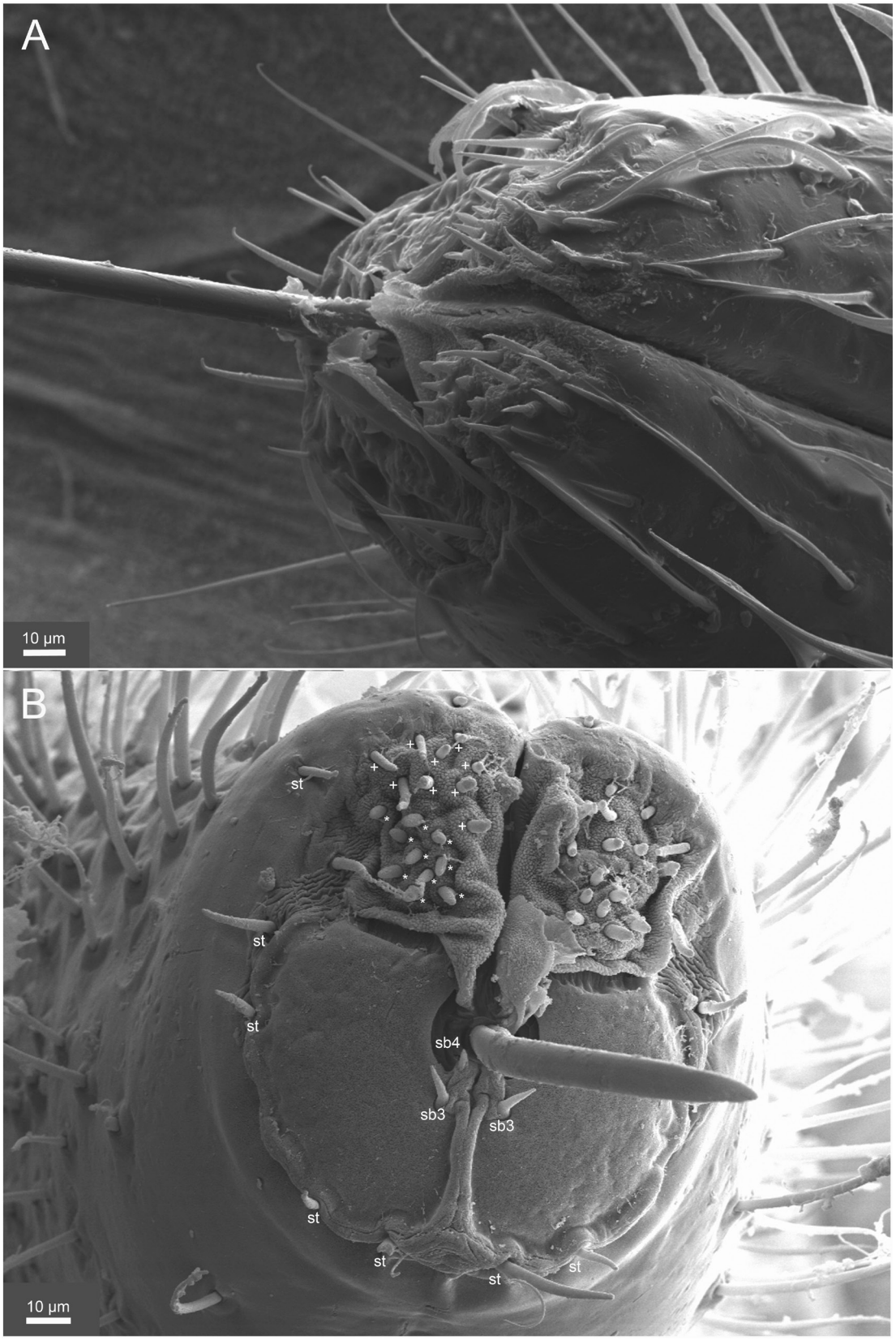


Plate fig. 59. Labium tip of *Issus coleoptratus*. A – sutural view. B – caudal view. Both specimens pre-treated overnight in a detergent solution before SEM. "*" = sensilla basiconica type 1, "+" = sensilla basiconica type 2, sb3-4 = sensilla basiconica type 3 and 4, st = sensilla trichoidea.

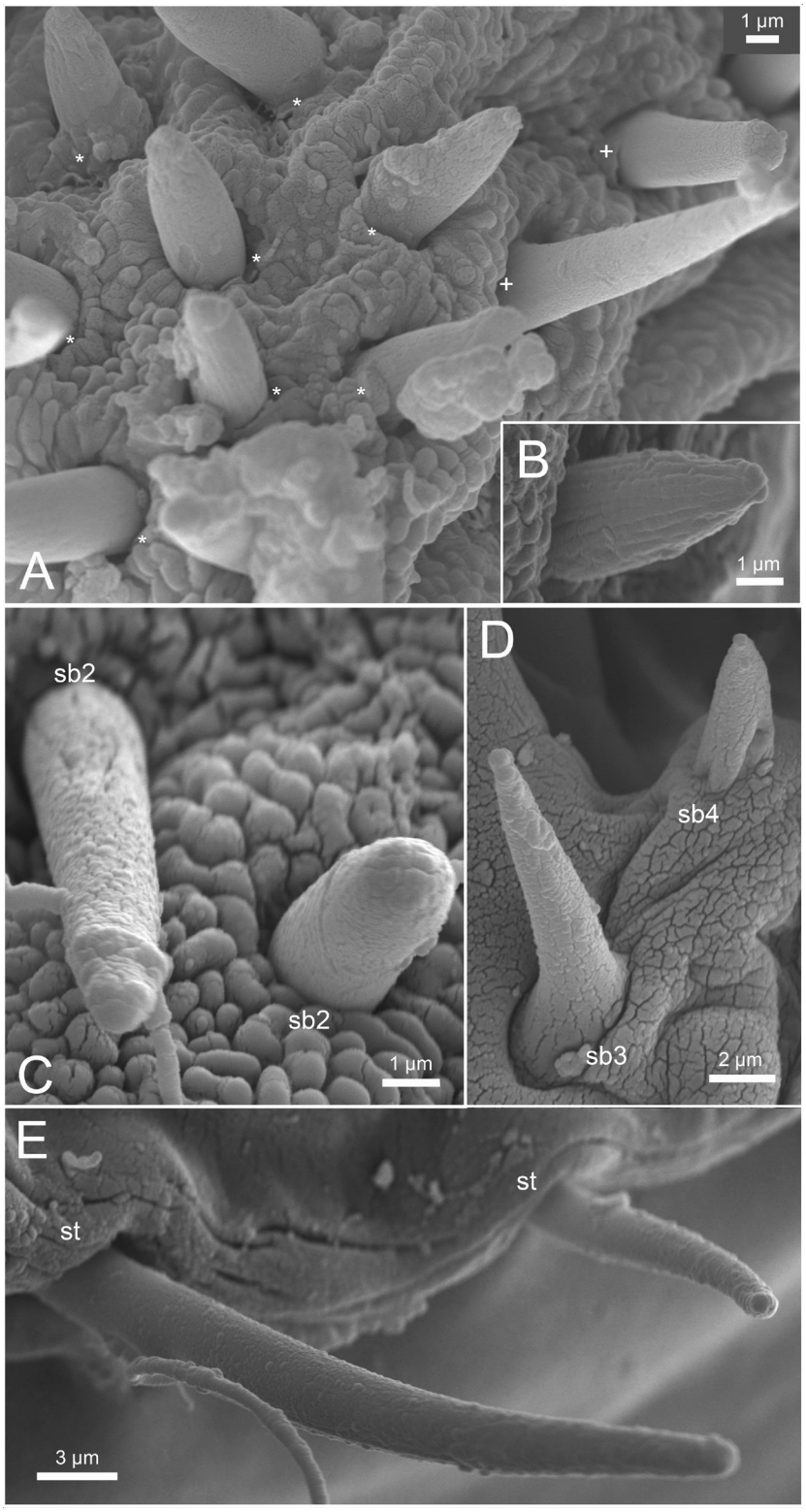


Plate fig. 60. Sensilla on labium tip of *Issus coleoptratus*. A – part of the sutural group of sensilla. B – a sensillum basiconicum type 1, magnified. C – two sensilla basiconica type 2; note their different length, tip form and secretion on the tip (and compare to the two type 2-sensilla in A). D – sensilla basiconica type 3 and 4, antisutural margin of the labium orifice. E – two sensilla trichodea on the antisutural edge of the labium tip. Abbreviations same as in fig. 94. Specimen in A pre-treated with vinegar, B-E – with detergent solution.

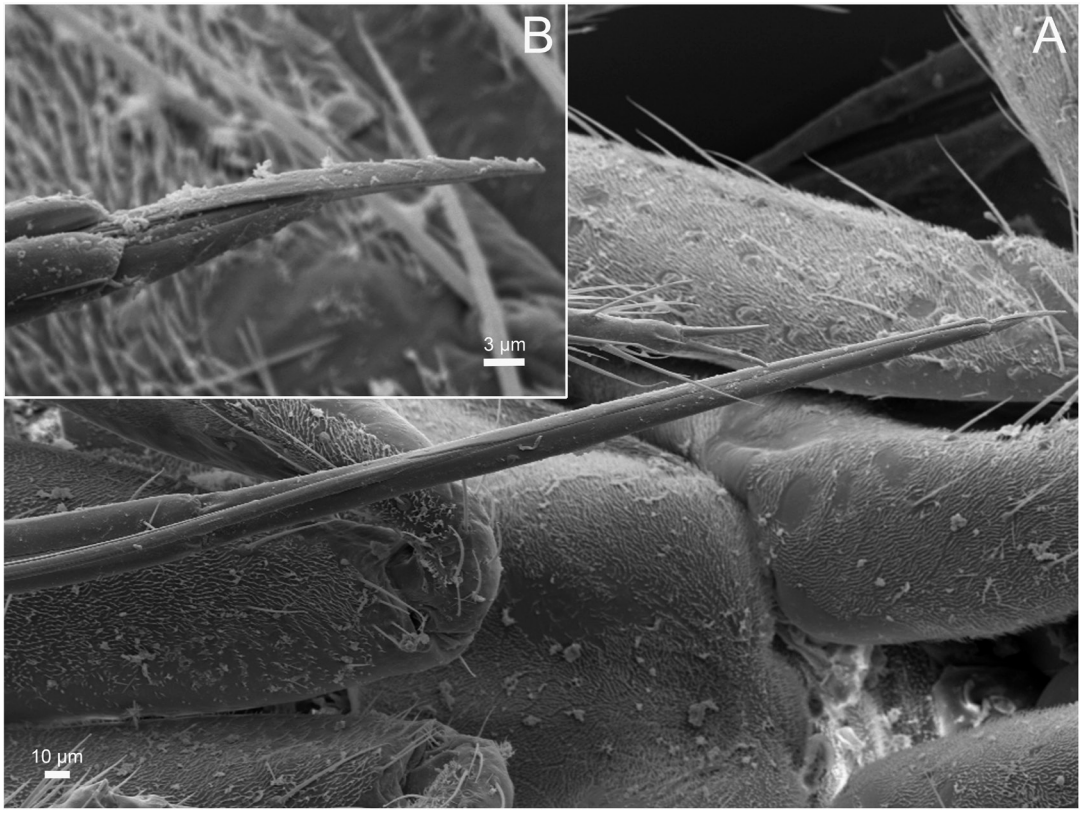


Plate fig. 61. Labium tip of *Ceratocombus* sp. A – last labial segment. B – labium tip with protruding tips of the stylets (mandibles are barbed on the sides).

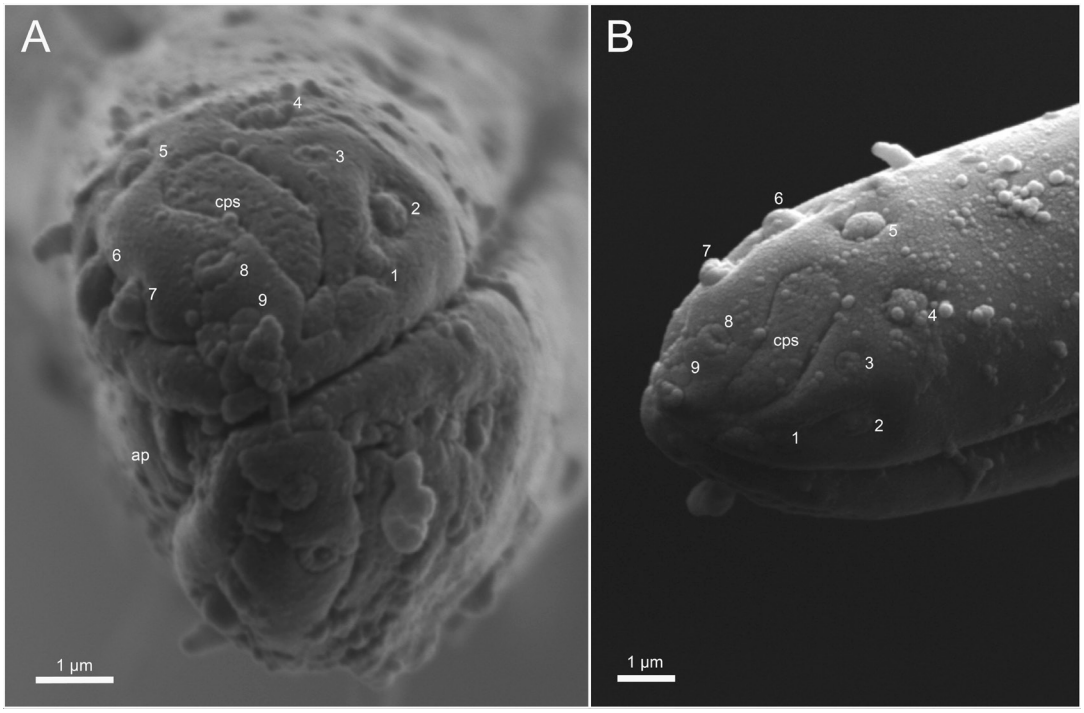


Plate fig. 62. Sensilla on the labium tip in *Ceratocombus* sp. A – caudal view. B – skewed lateral view. ap = apical plate; cps = central placoid sensillum (multiporous); peripheral placoid sensilla with central pores are numbered.

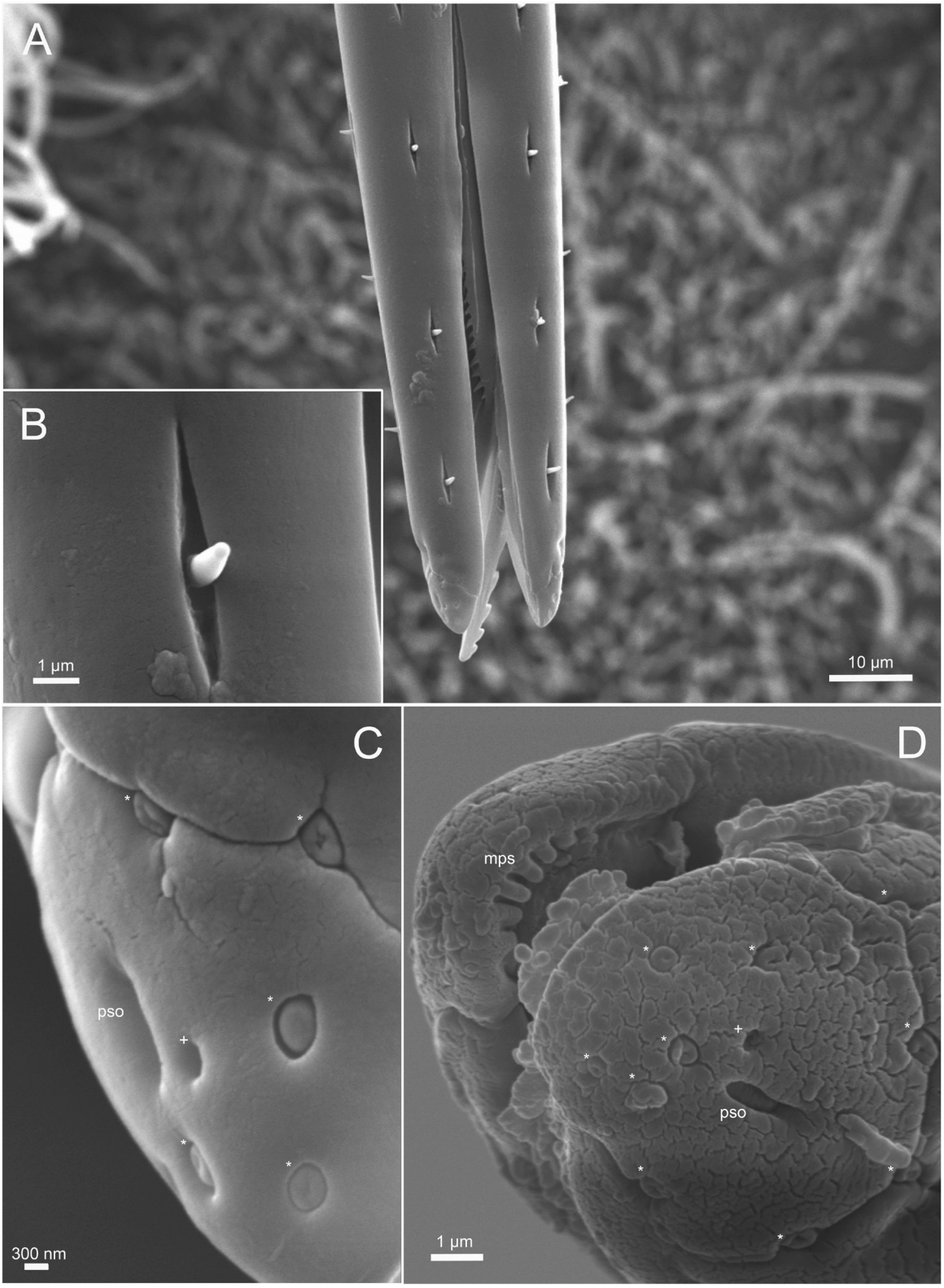


Plate fig. 63. Labium tip of *Saldula saltatoria*. A – general view; note the barbed maxilla visible in the groove. B – a trichoid sensillum on the sutural side, magnified. C – left side of the labium tip, sutural view. D – right side of the labium tip, lateral view; inner regions of the opening with a multi-peg structure (mps) are visible. Asterisks denote placoid sensilla with a central pore; plus denotes the coeloconic sensillum, pso = placoid sensillum, oblong (multiporous).

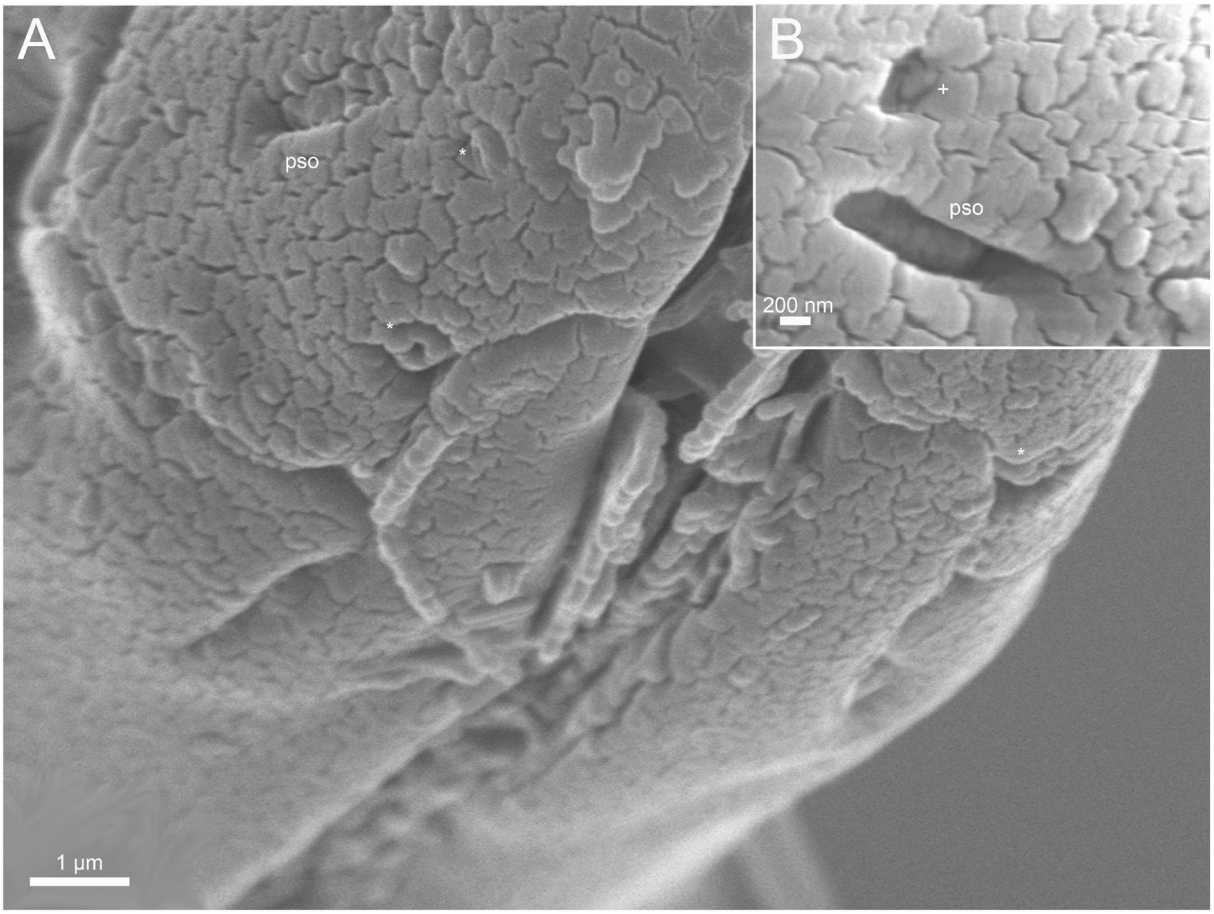


Plate fig. 64. Labium tip of *Saldula saltatoria*. A – antisutural view; note the longitudinal fissure parallel to the labial groove, and cuticular folds bordering the tip region. B – placoid sensillum oblong, magnified. Abbreviations same as in the fig. 63.

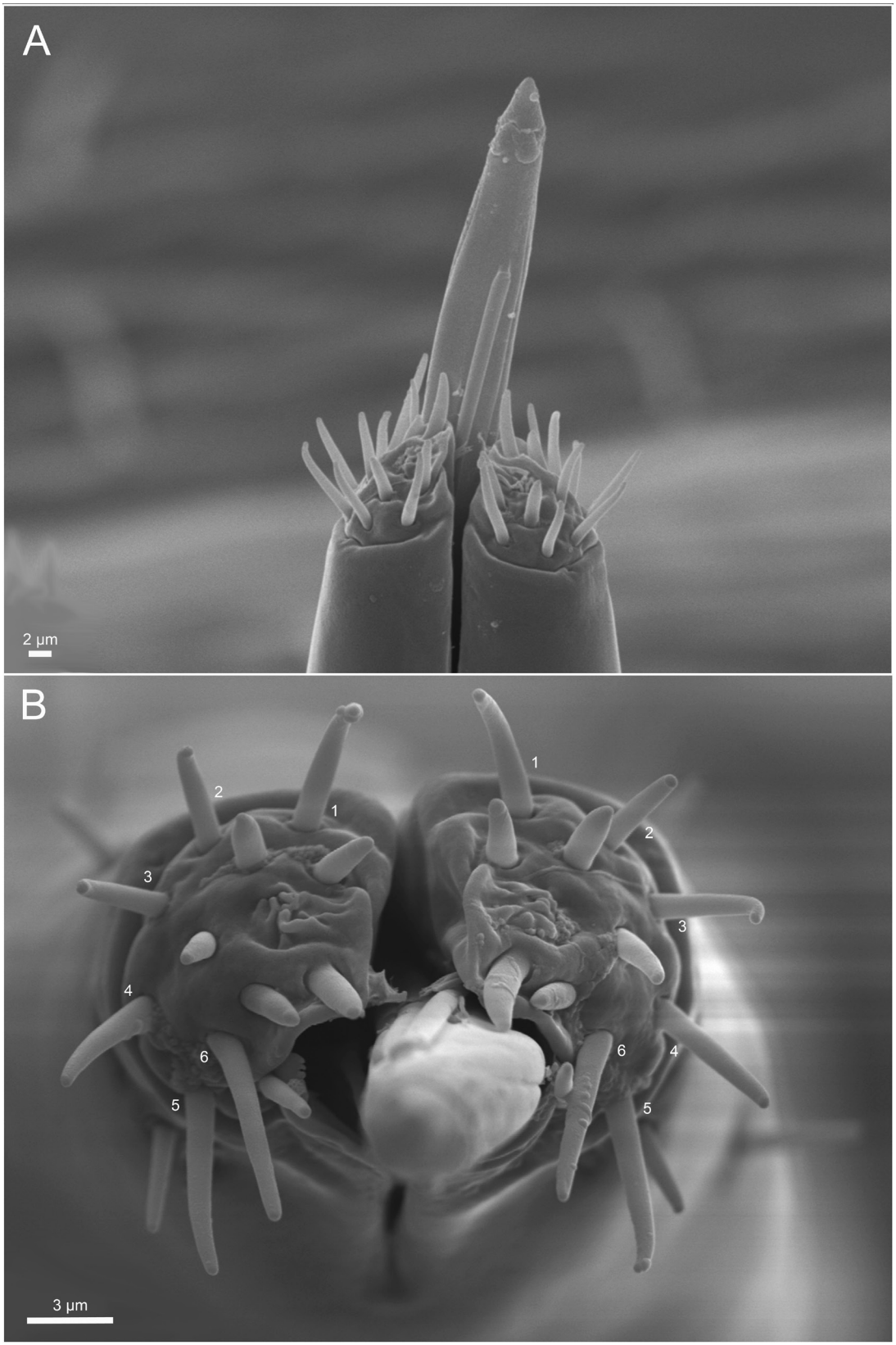


Plate fig. 65. Labium tip in *Corythucha ciliata*. A – sutural view. B – caudal view; basiconic sensilla of the outer circle are numbered. Note the twist of the mandibles (the fissure connecting them is lateral, not dorsoventral).

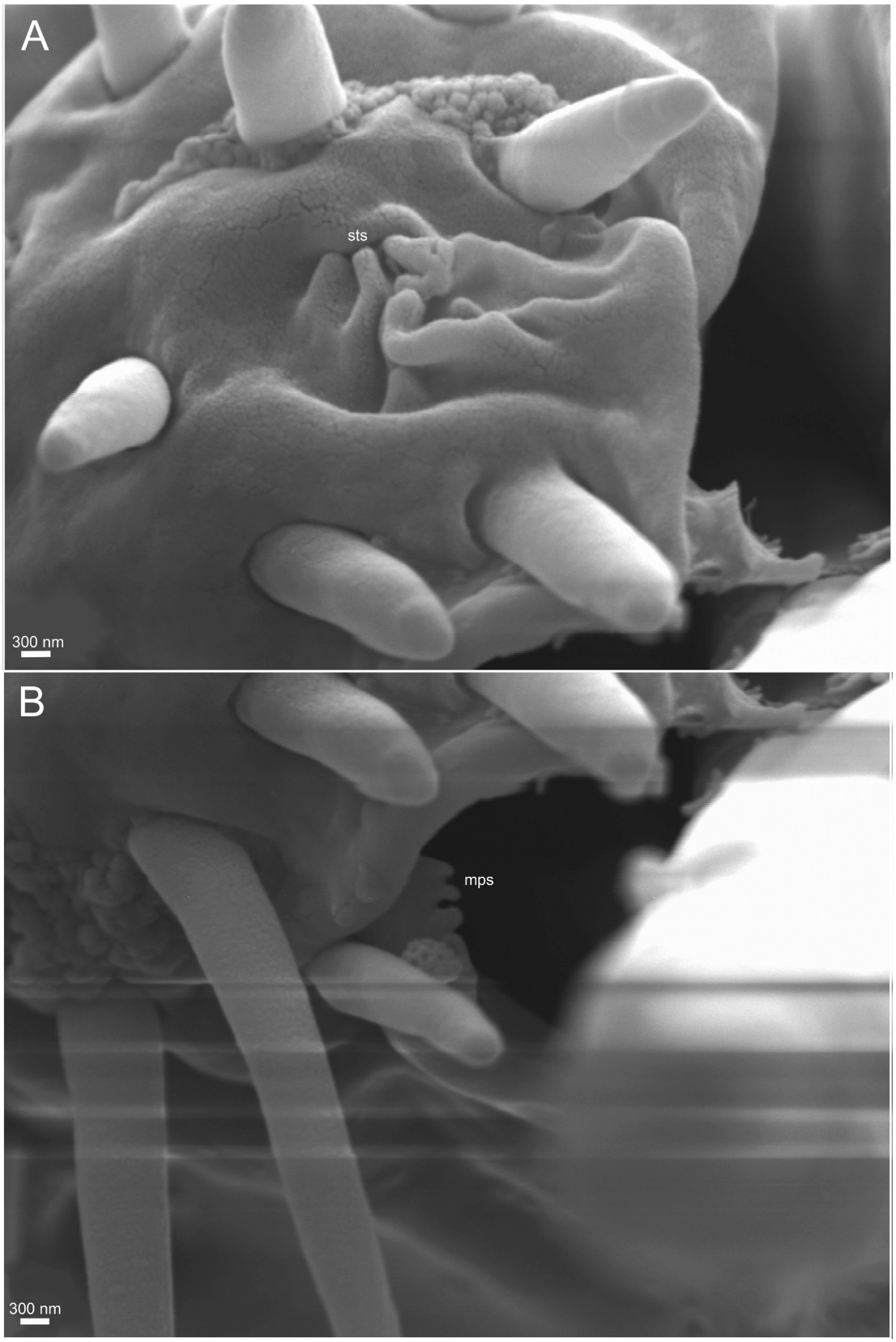


Plate fig. 66. Sensilla of the labium tip in *Corythucha ciliata*. A – stellar folded structure (sts) and the inner basiconic sensilla surrounding it. B – antisutural region of the labium orifice and basiconic sensilla surrounding it; mps = multi-peg structure.

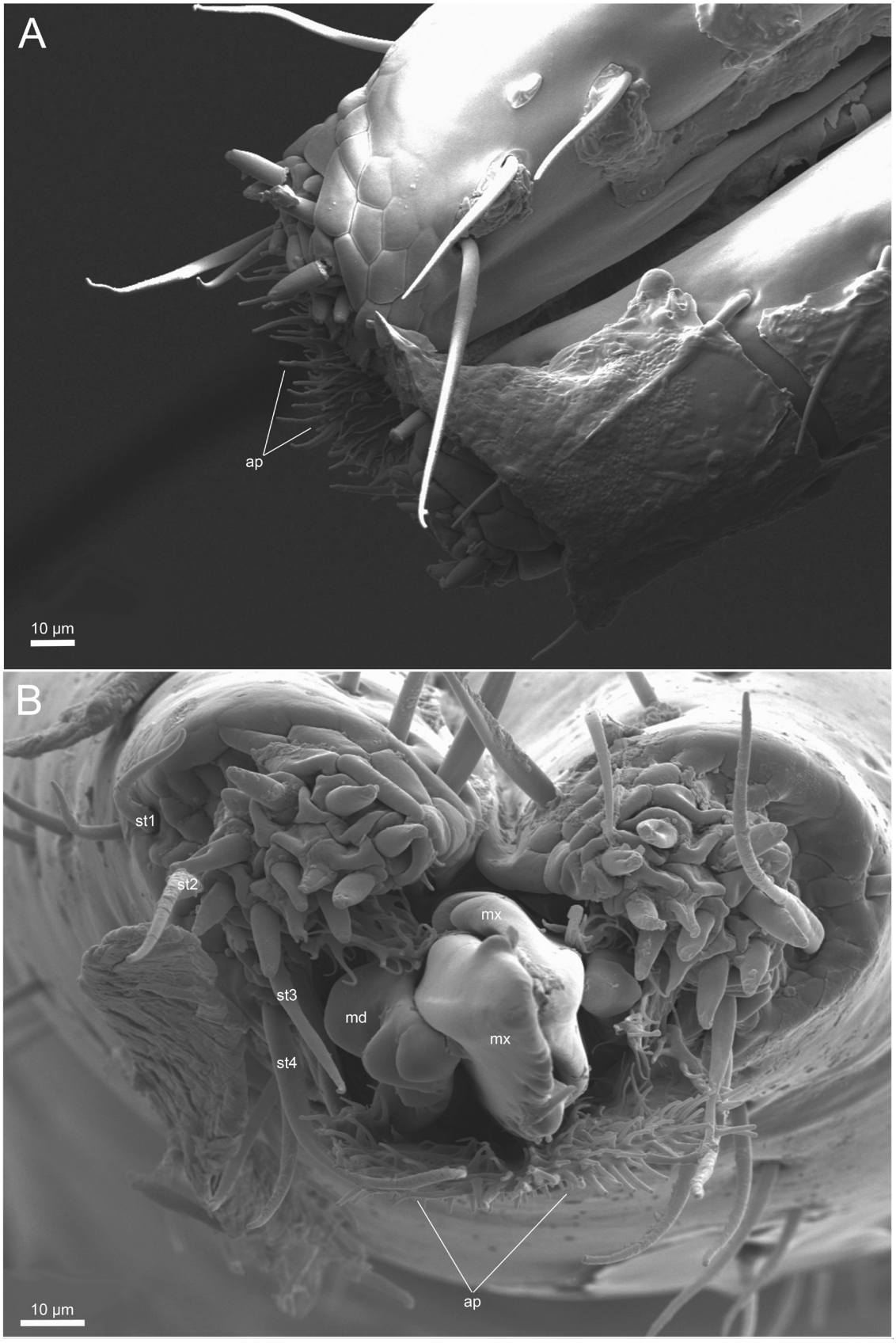


Plate fig. 67. Labium tip of *Pyrrhocoris apterus*. A – sutural view. B – caudal view. ap = apical plate, md = mandible, mx = maxilla, st1-4 = sensilla trichodea 1-4.

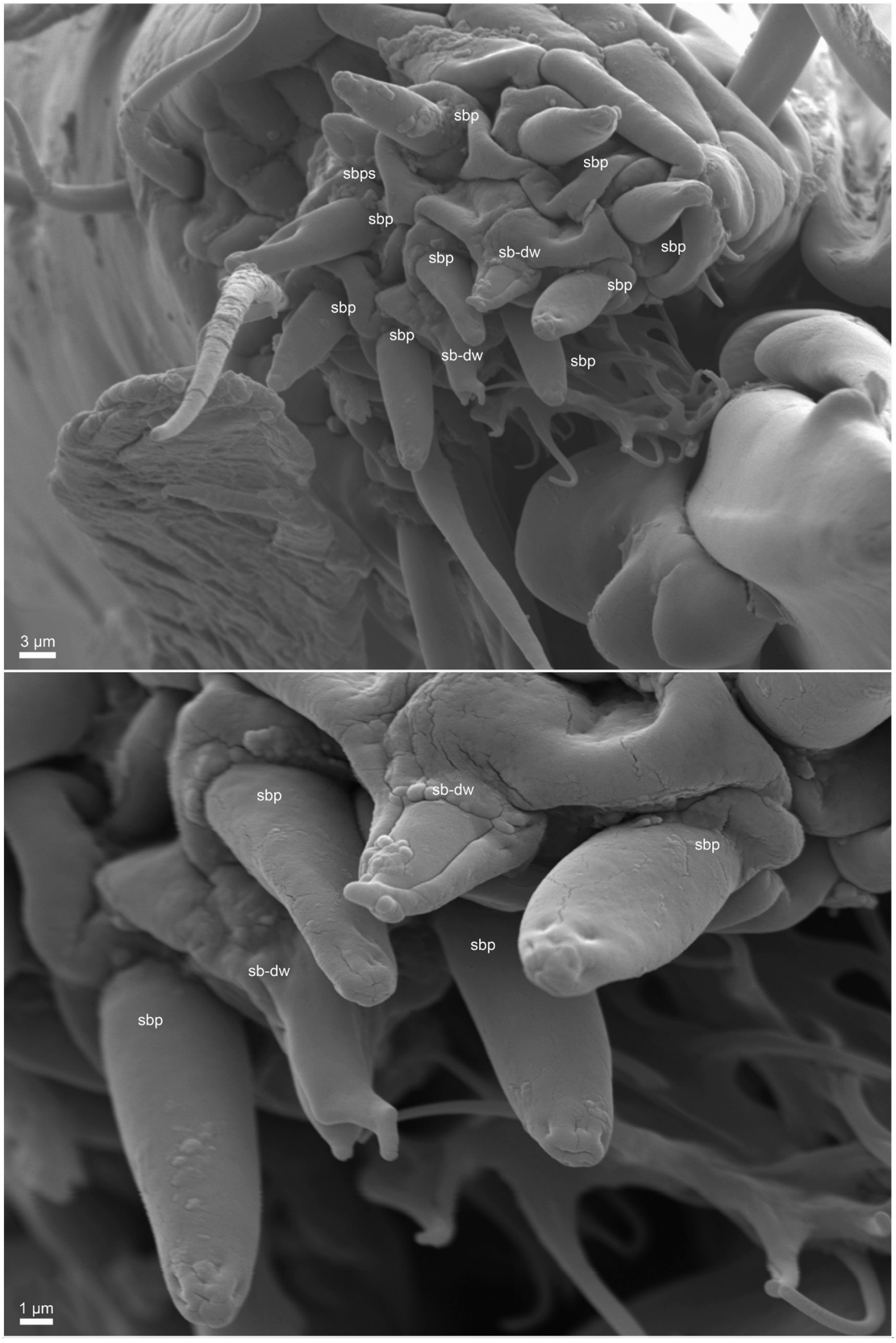


Plate fig. 68. Sensilla of the labium tip in *Pyrrhocoris apterus*. A – general view. B – representatives of the two main sensilla types magnified. sb-dw = sensilla basiconica, double-walled; sbp = sensilla basiconica, porose; sbps = sensilla basiconica, porose, small.

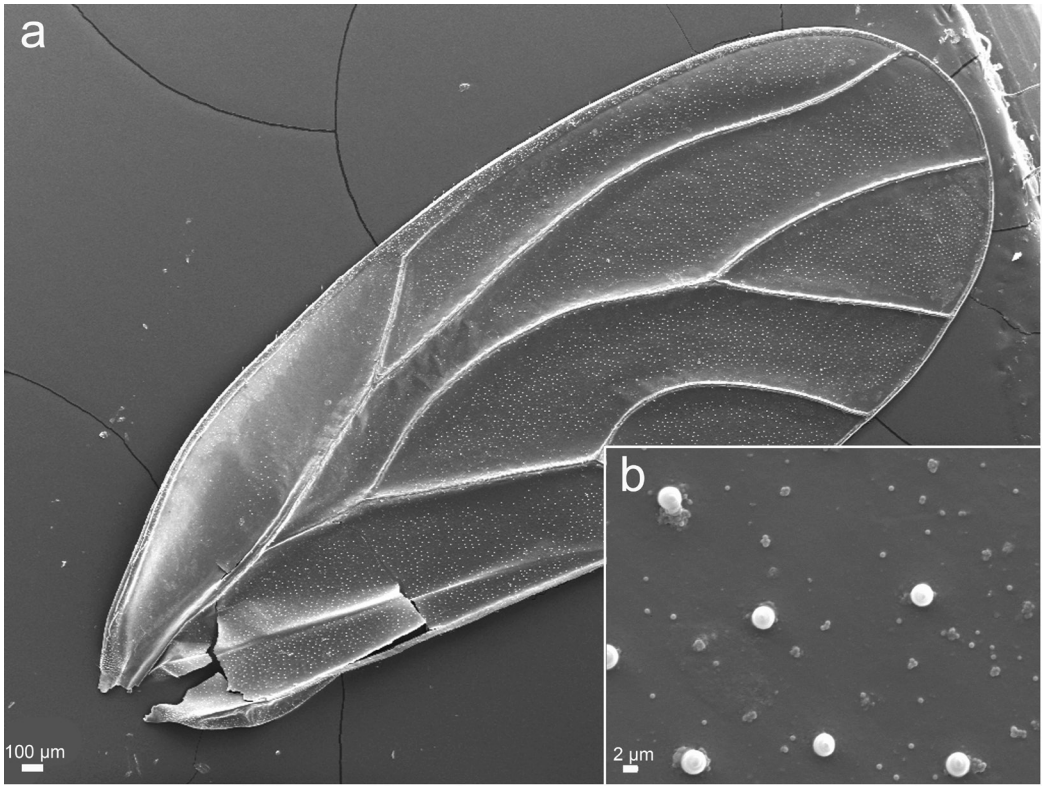


Plate fig. 69. Tegmen of *Psylla alni*, ventral view. a – general view; b – a region of the tegmen with microtrichia magnified.

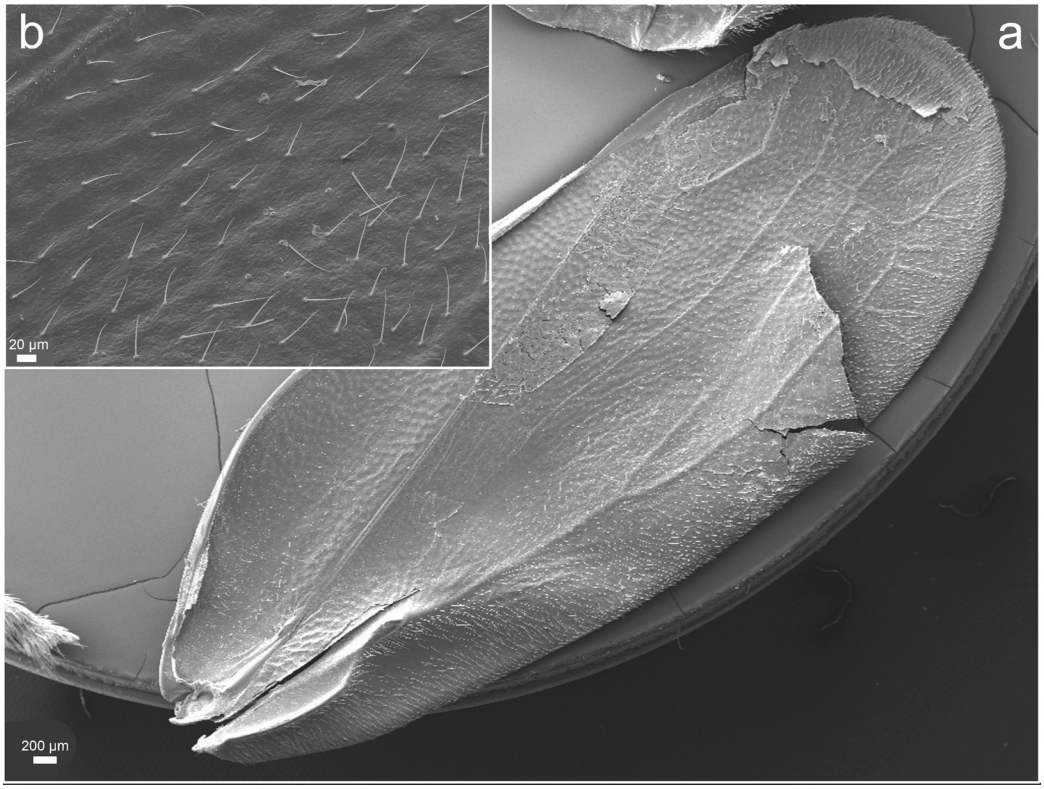


Plate fig. 70. Tegmen of *Cercopis sanguinolenta*, ventral view. a – general view; b – a region of the tegmen with sensilla trichodea and microtrichia magnified.

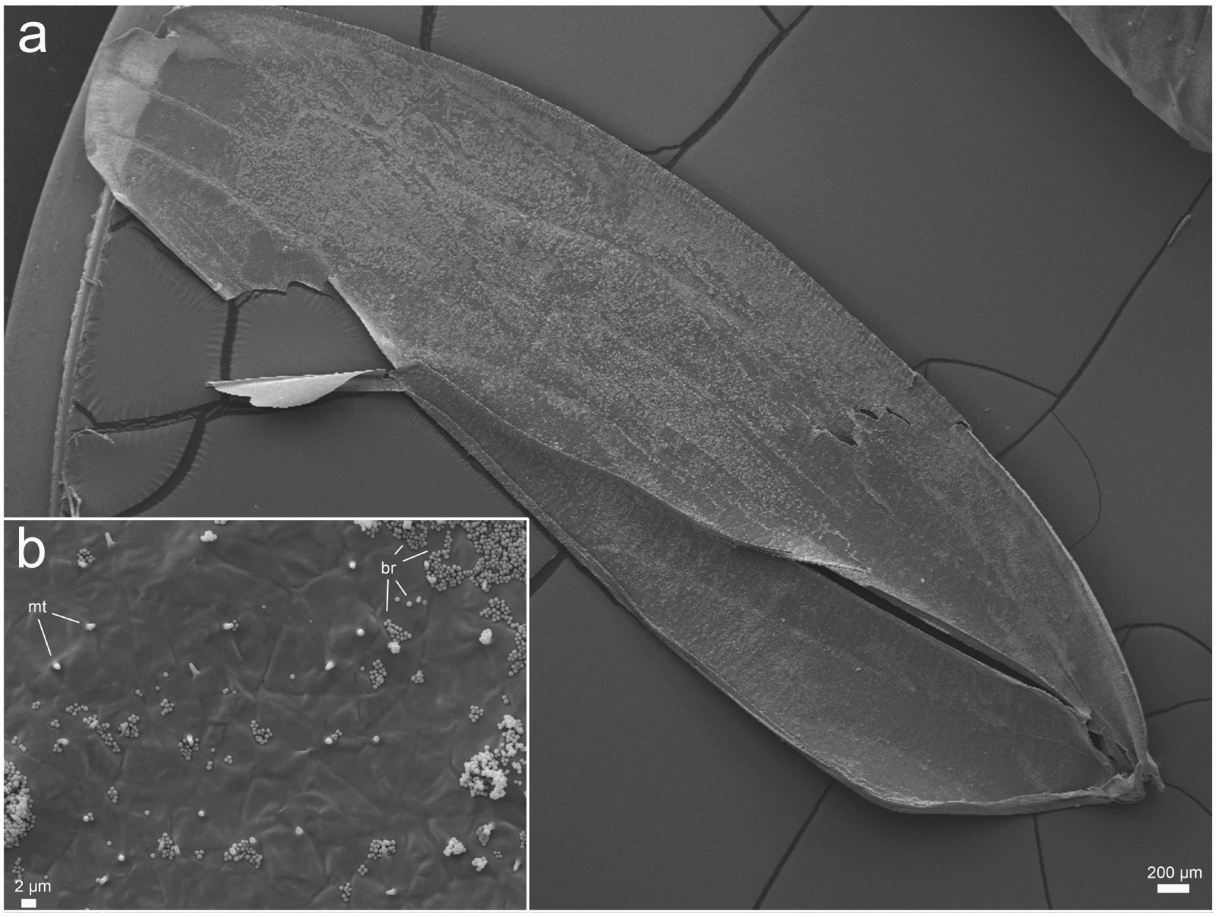


Plate fig. 71. Tegmen of *Cicadella viridis*, ventral view. a – general view; b – a region of the tegmen with microtrichia magnified; br = brochosomes, mt = microtrichia.

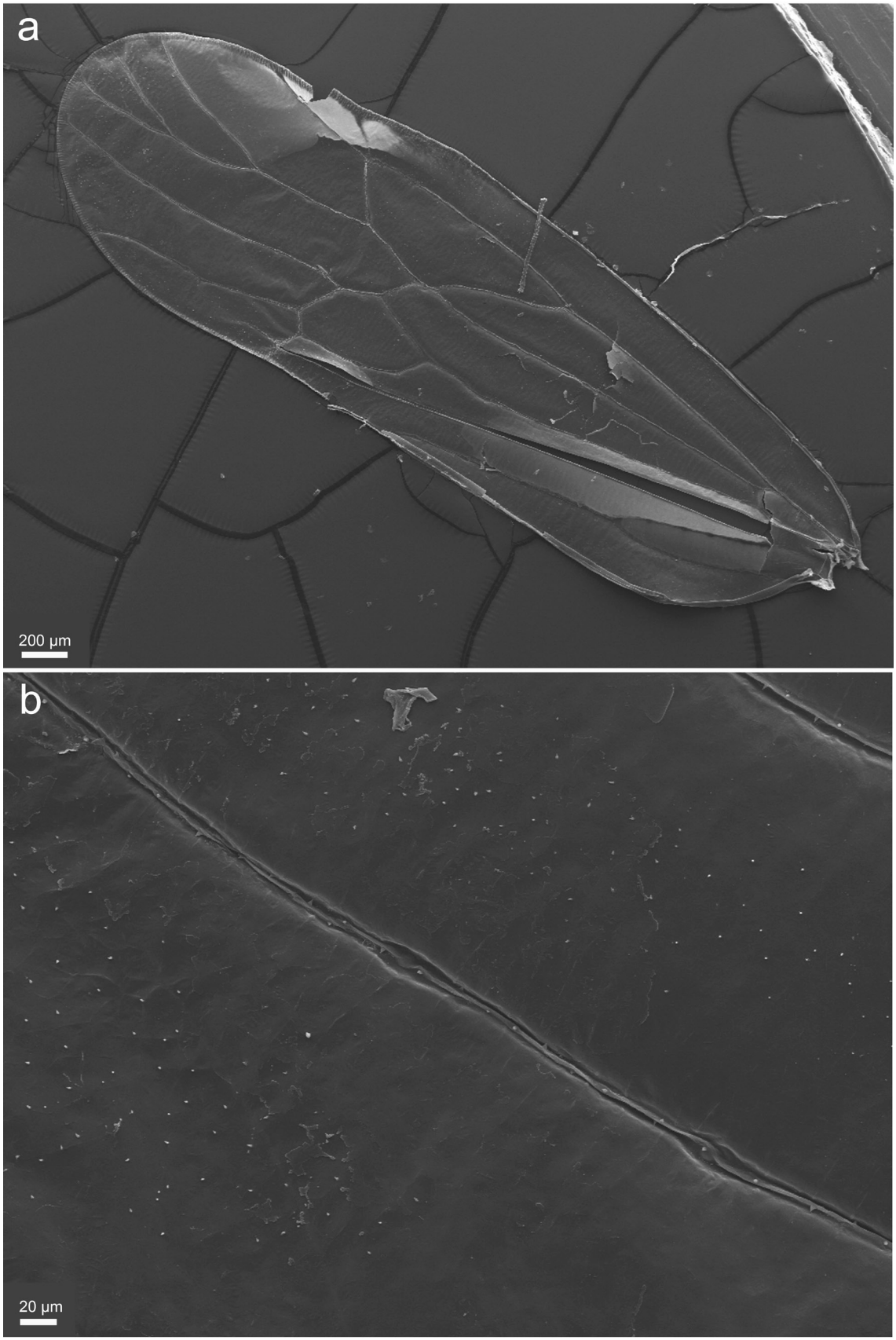


Plate fig. 72. Tegmen of *Laodelphax striatella*, ventral view (chloroform-treated specimen). a – general view, b – part of a distal region with microtrichia. Not the absence of wax-like secretion.

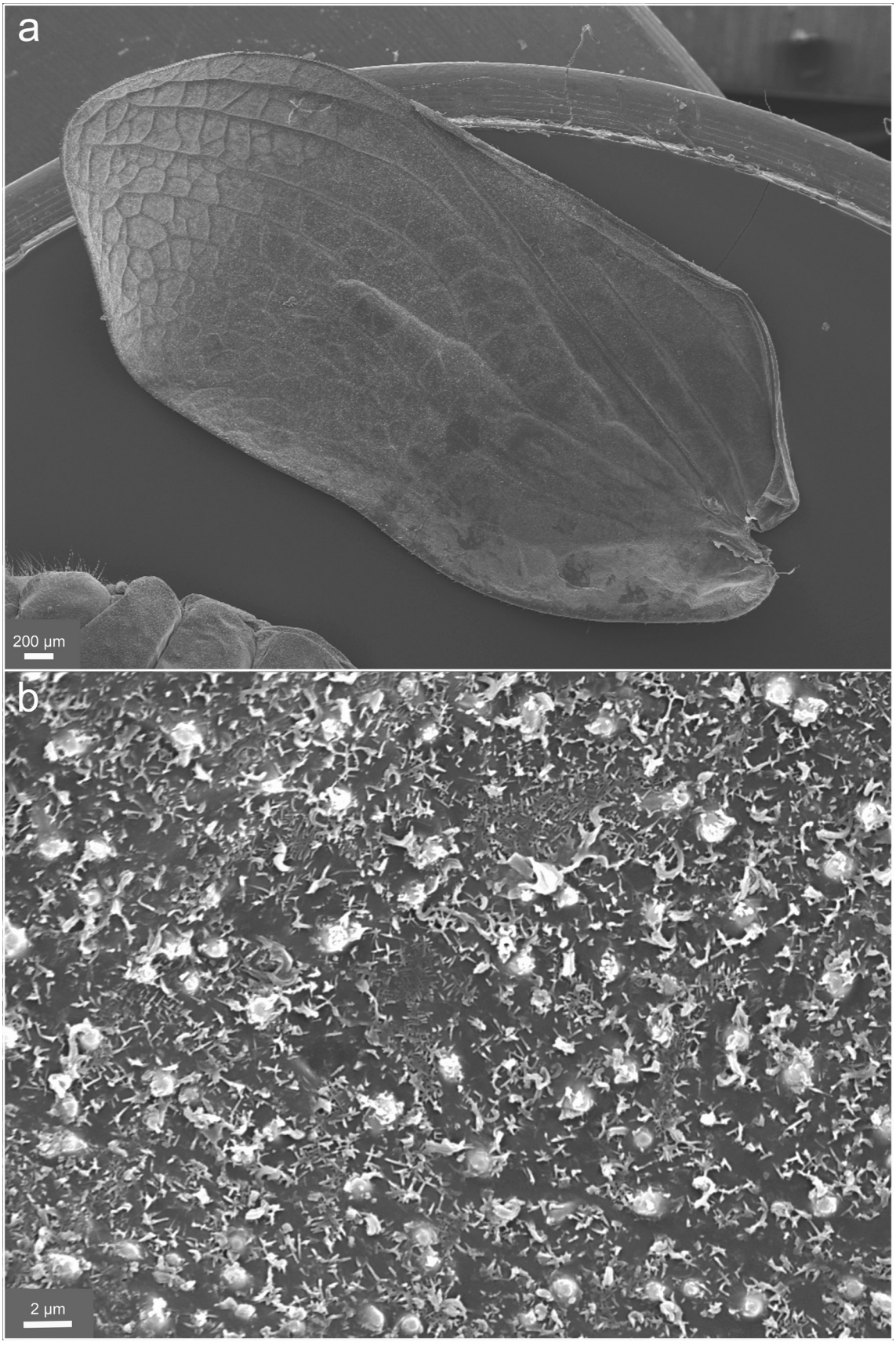


Plate fig. 73. Tegmen of *Issus coleoptratus*, ventral view. a – general view, b – fragment of a, magnified, with microtrichia and wax-like secretion.

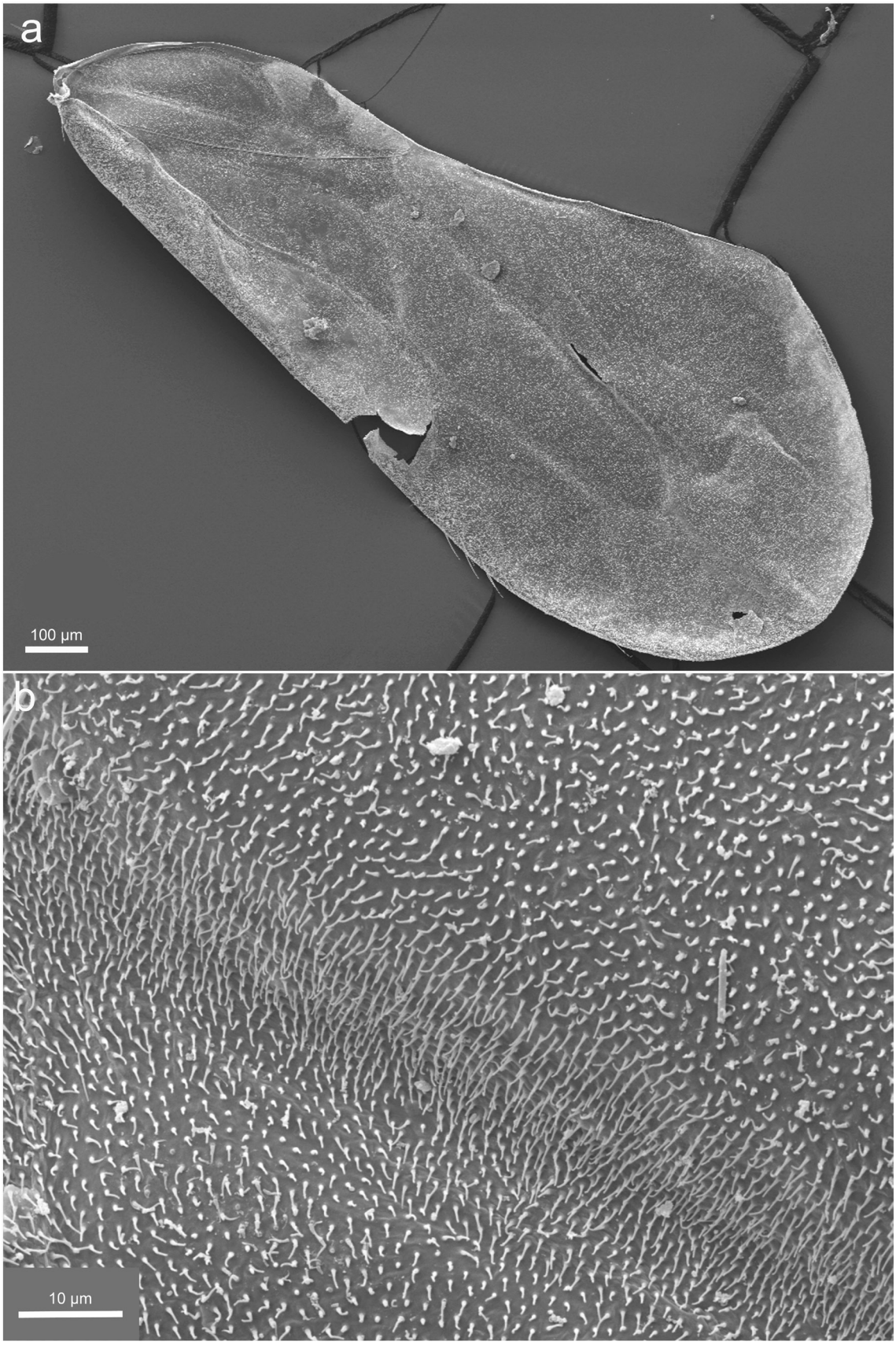


Plate fig. 74. Tegmen of *Ceratocombus* sp., ventral view. a – general view; b – fragment of a, magnified, with microtrichia.

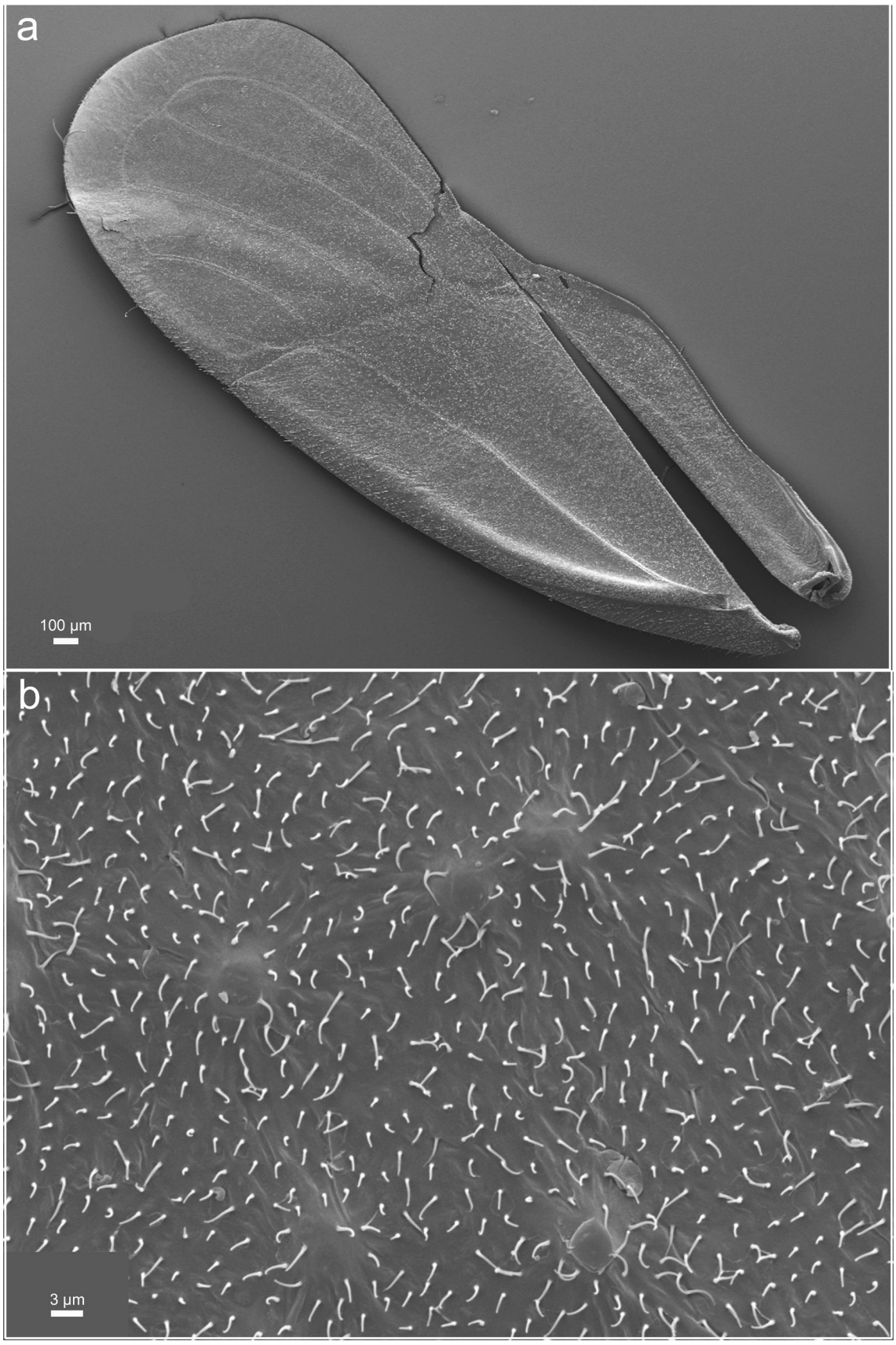


Plate fig. 75. Tegmen of *Saldula saltatoria*, ventral view. a – general view; b – fragment of a, magnified, with microtrichia.

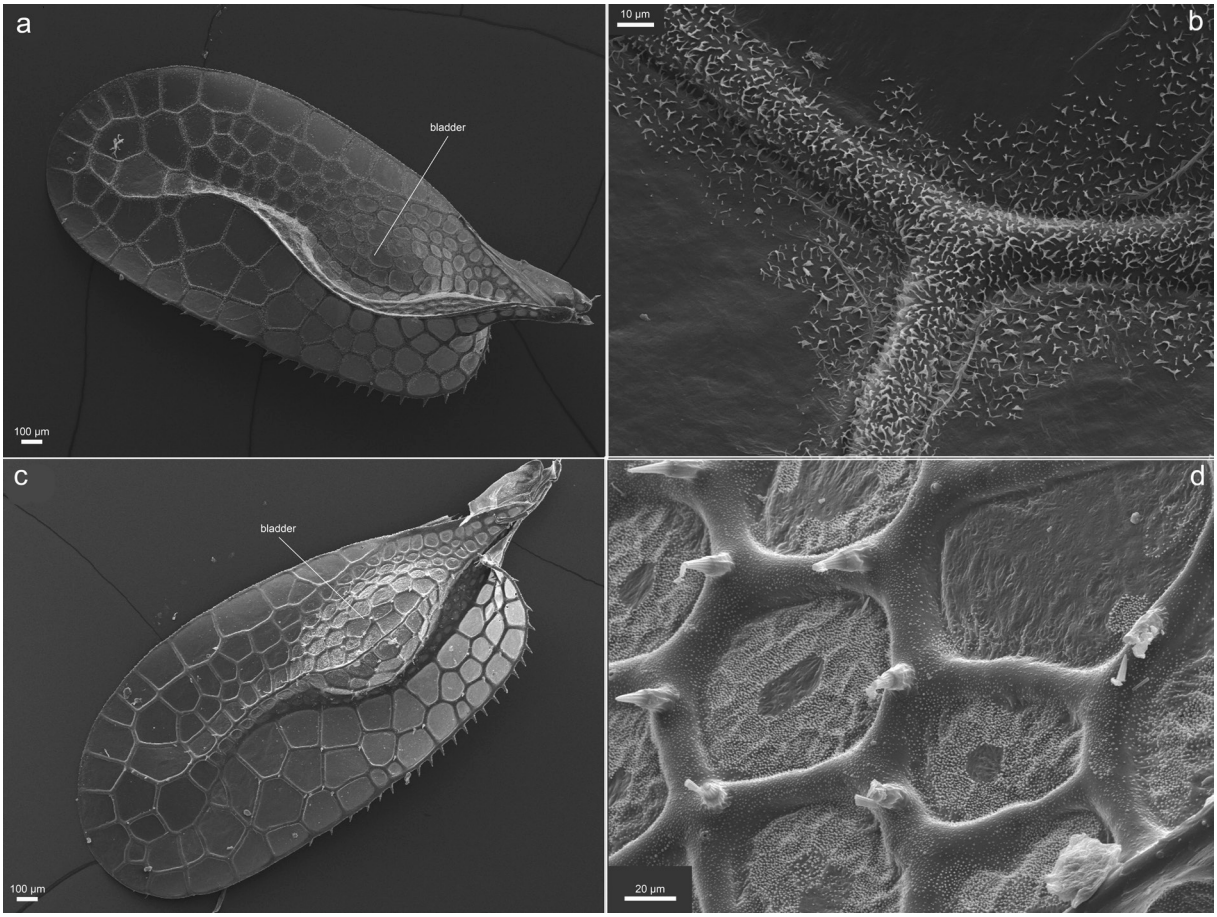


Plate fig. 76. Tegmina of *Corythucha ciliata*. “Bladder” denotes the inflated region on the tegmen that often occurs in the family Tingidae. a – general view, ventrally; b – fragment of a, magnified, with microtrichia; c – general view, dorsally; d – fragment of the bladder-like region, magnified, with microtrichia on and between the veins and large acanthae on the veins.

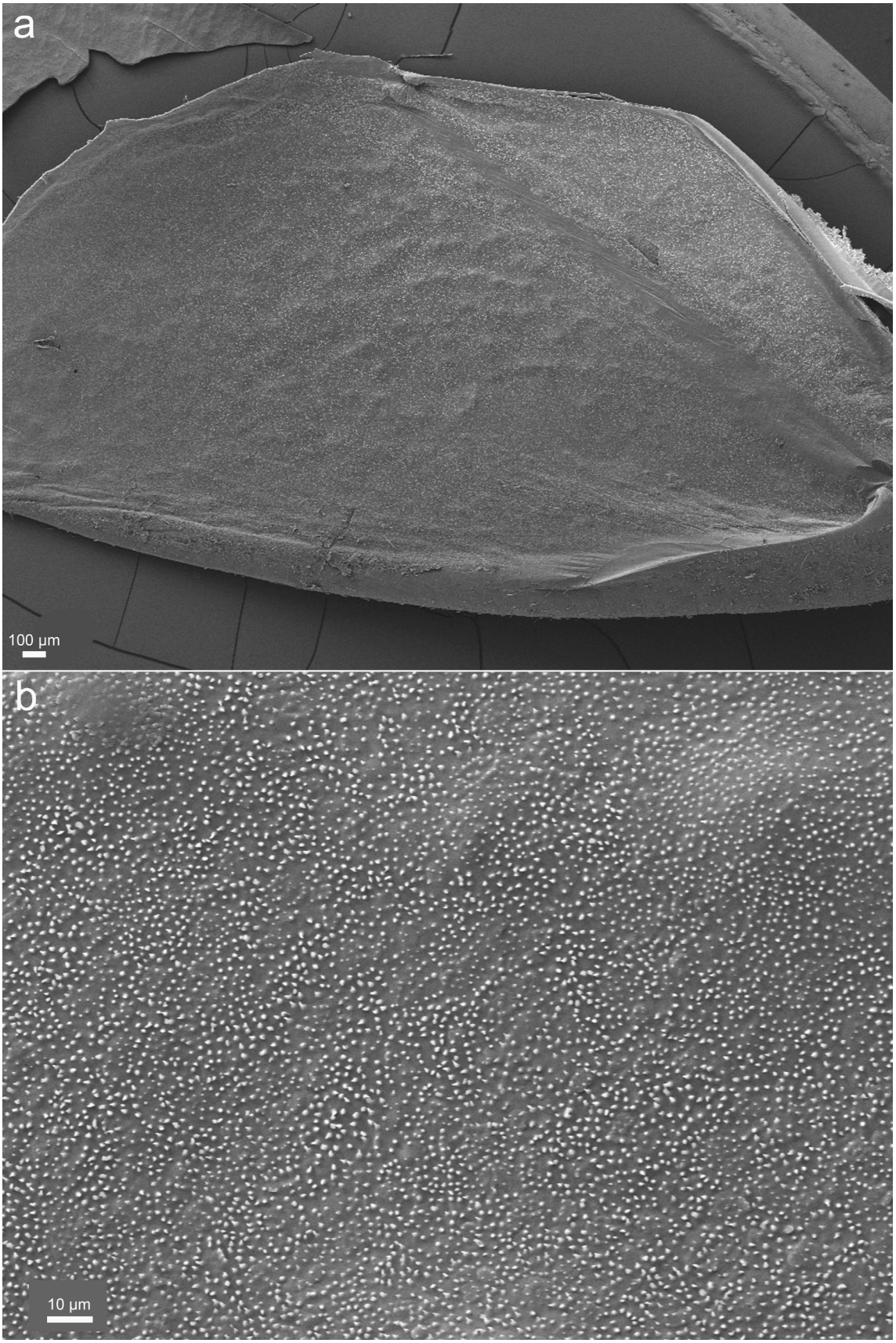


Plate fig. 77. Tegmen of *Pyrrhocoris apterus*, ventral view. a – general view; b – fragment of a, magnified, with microtrichia.

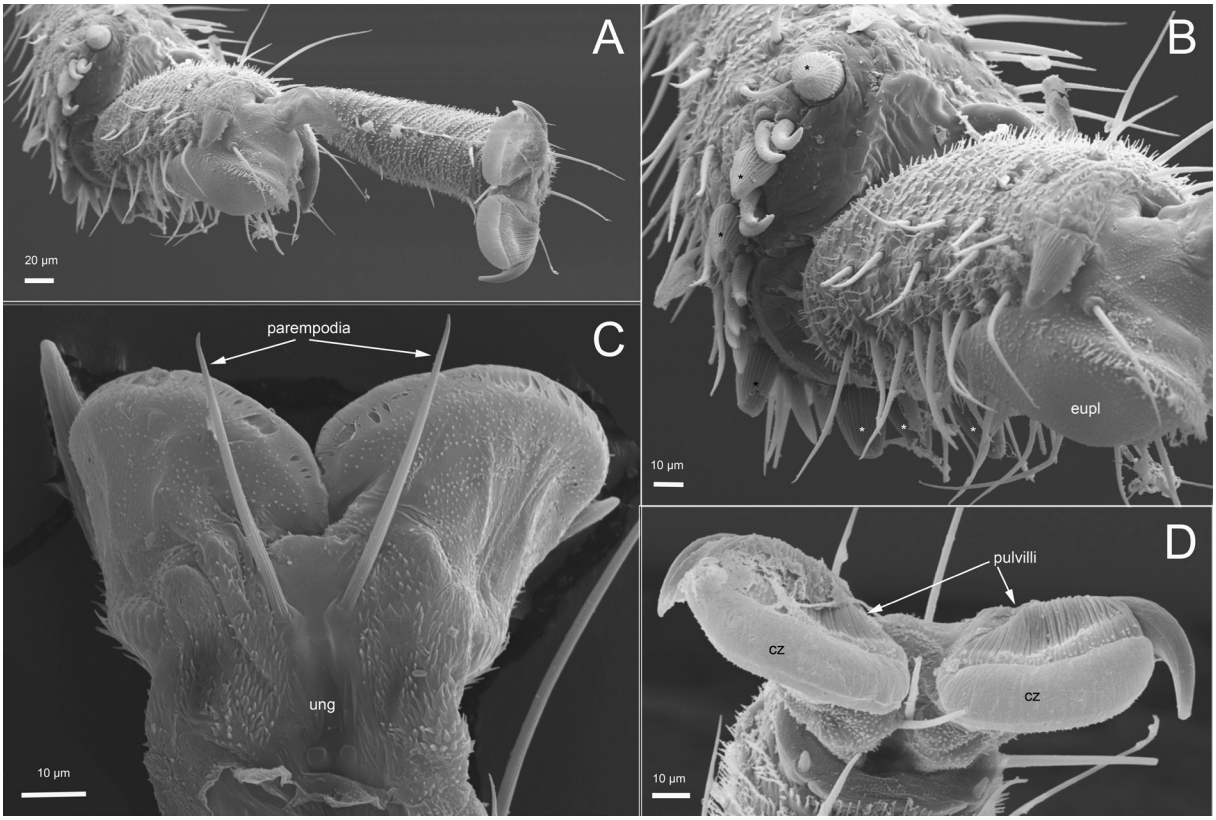


Plate fig. 78. Distal region of the hind leg of *Psylla alni*. A – general view; B – distal tibia and the first tarsal segment, ventral view, magnified; tibial spurs are denoted with asterisks; eupl = euplantula; C – pretarsus, ventral view, magnified; ung = unguitractor; D – pretarsus, frontal view, magnified; cz = contact zone of the pulvillus.

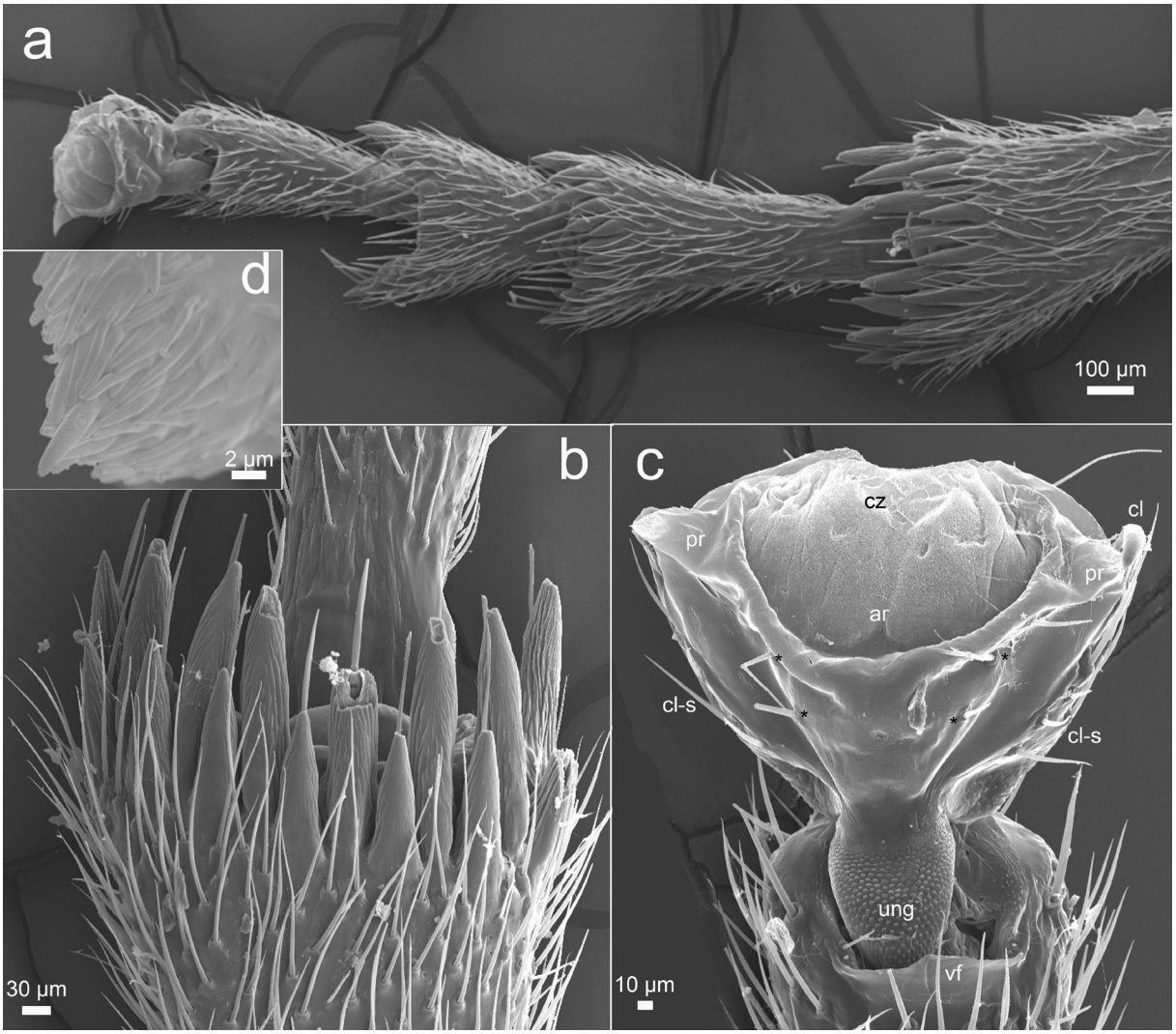


Plate fig. 79. Distal region of the hind leg of *Cercopis sanguinolenta*. a – general view; b – distal tibia, magnified; c – pretarsus, ventral view, magnified; ar = arolium, cl = claws, cl-s = claw setae, cz = contact zone of the arolium, pr = protrusion of the arolium; ung = unguitractor; asterisks denote the positions of the setae on the arolium; d – tip of the protrusion on the arolium, magnified.

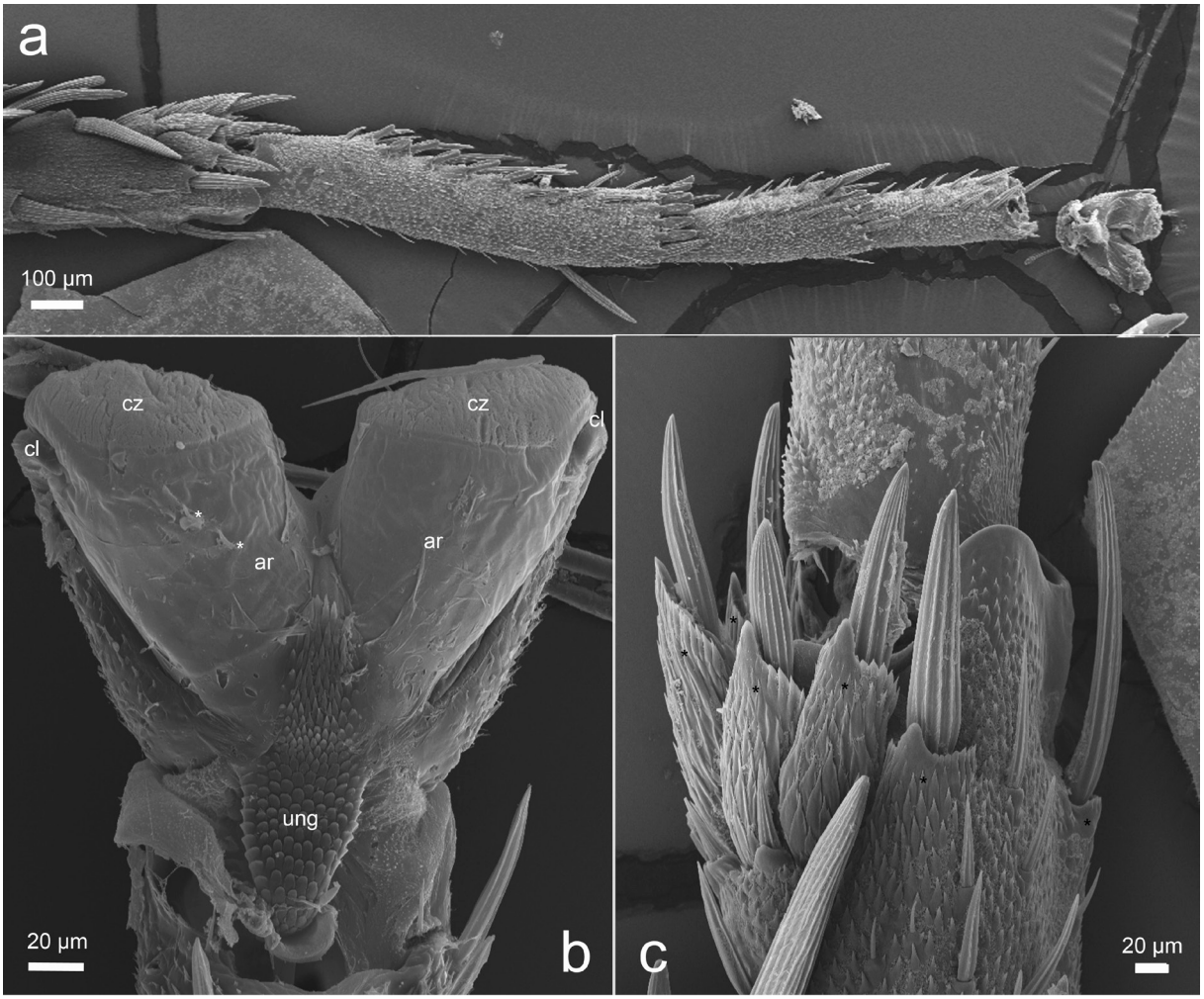


Plate fig. 80. Distal region of the hind leg of *Cicadella viridis*. a – general view; b – pretarsus (different specimen from a and c), ventral view, magnified; ar = arolium (bilobed), cl = claw, cz = contact zones of the arolium, ung = unguitractor; c – distal tibia, magnified; asterisks denote the elevated sockets of setae.

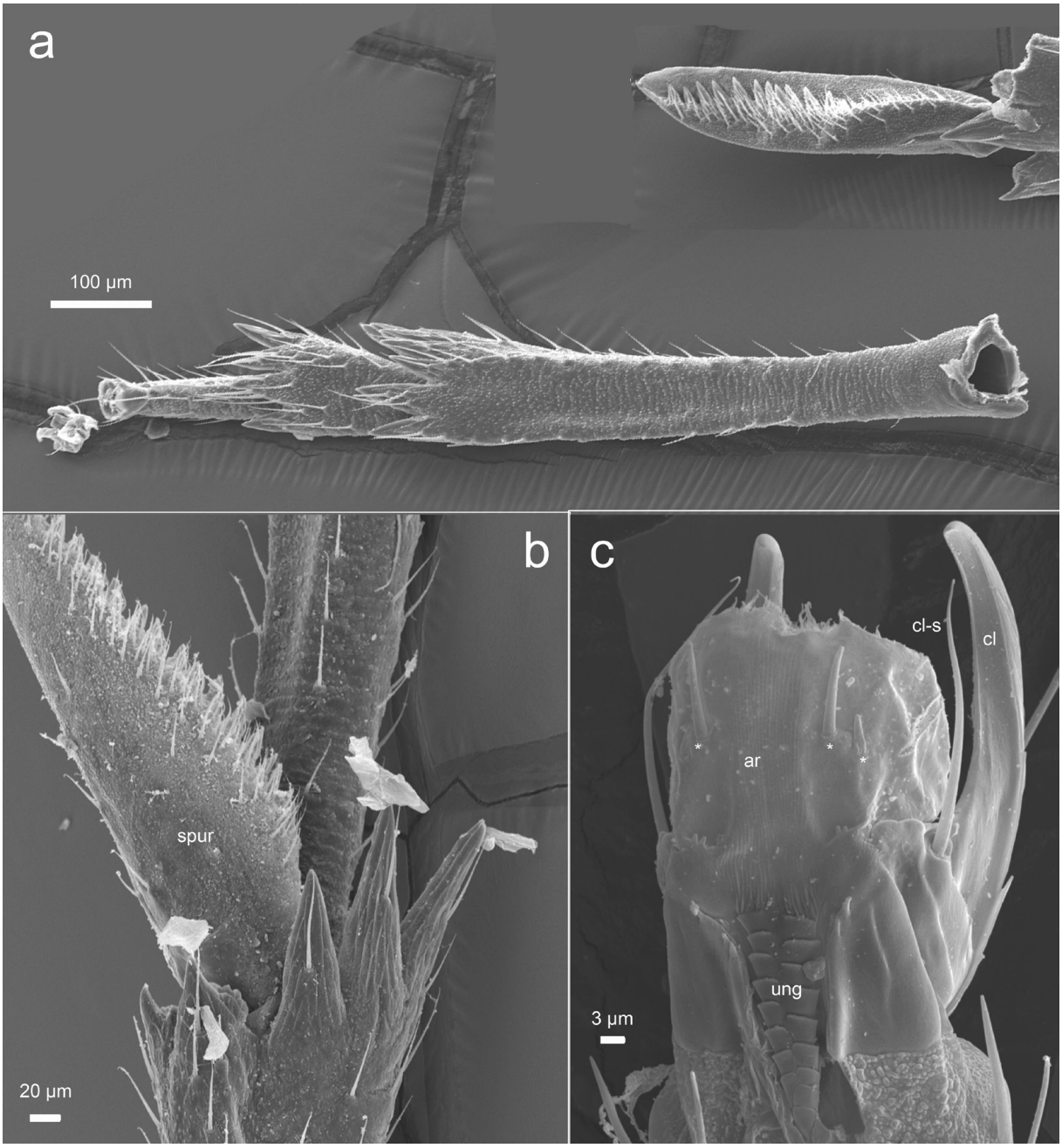


Plate fig. 81. Distal region of the hind leg of *Laodelphax striatella*. a – general view (different specimen from b and c); b – distal tibia, ventral view, magnified; spur = tibial spur (autapomorphy of Delphacidae); c – pretarsus, ventral view, magnified; ar = arolium, cl = claw, cl-s = claw seta, ung = unguitractor; asterisks denote the setae on the arolium.

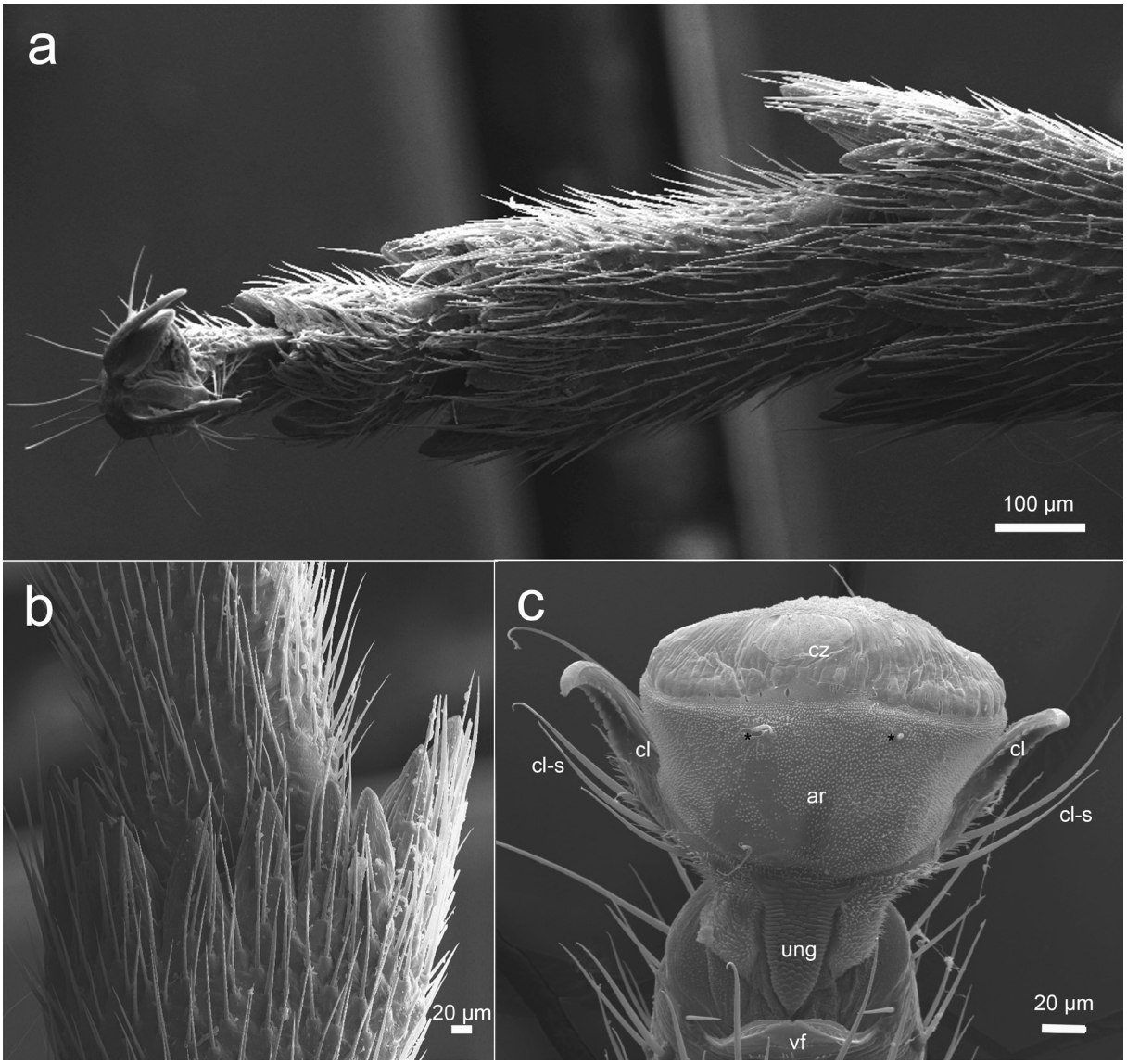


Plate fig. 82. Distal region of the hind leg of *Issus coleoptratus.* a – general view; b – distal tibia, ventral view, magnified; c – pretarsus (different specimen from a and b), ventral view, magnified; ar = arolium, cl = claw, cl-s = claw seta, cz = contact zone, ung = unguitractor; asterisks denote the setae on the arolium.

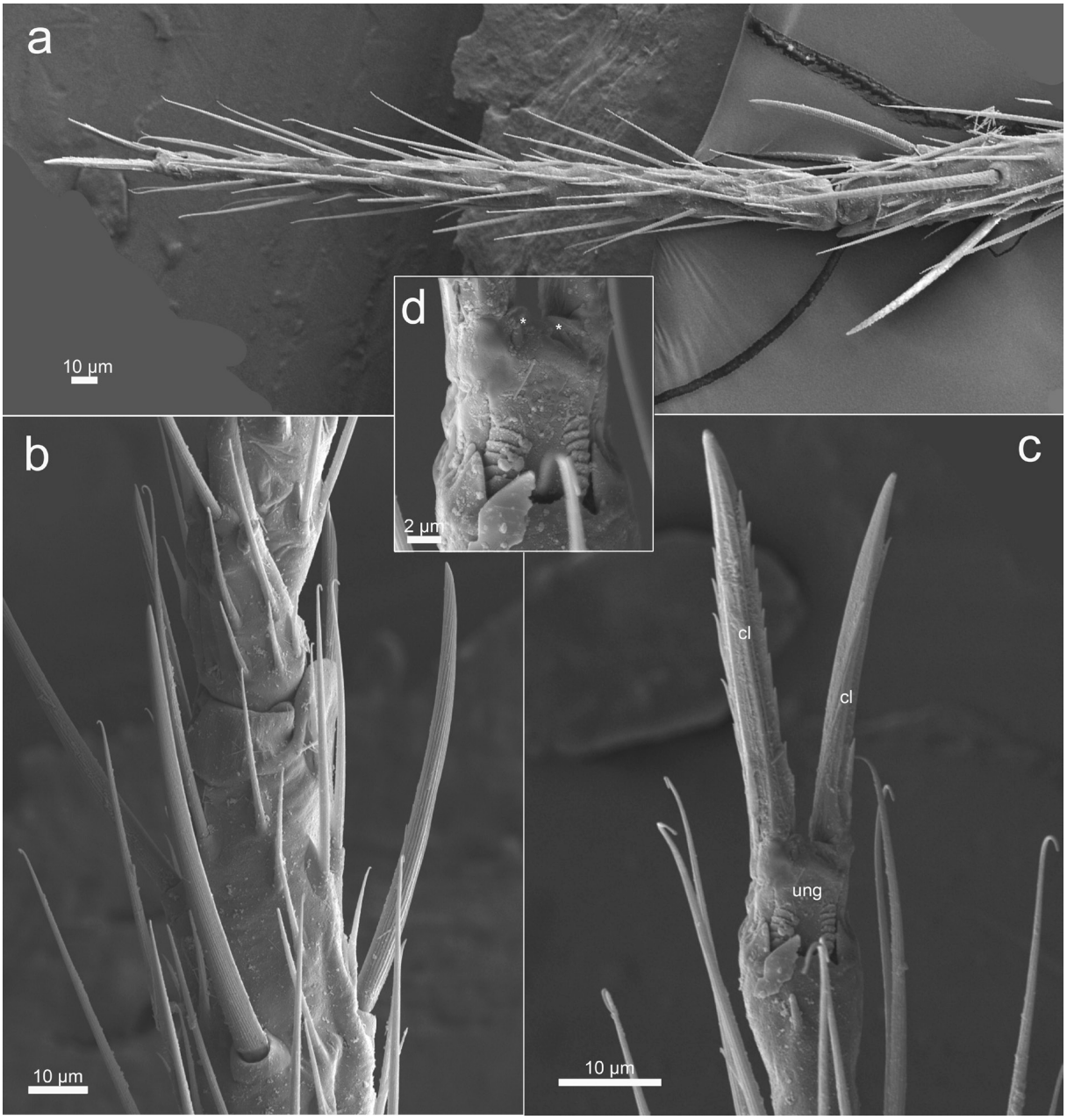


Plate fig. 83. Distal region of the hind leg of *Ceratocombus* sp. a – general view; b – distal tibia, ventral view; note the large fluted setae; c – pretarsus, ventral view; cl = claws, ung = unguitractor; d – unguitractor from c, magnified; asterisks denote the positions of minute accessory parempodia.

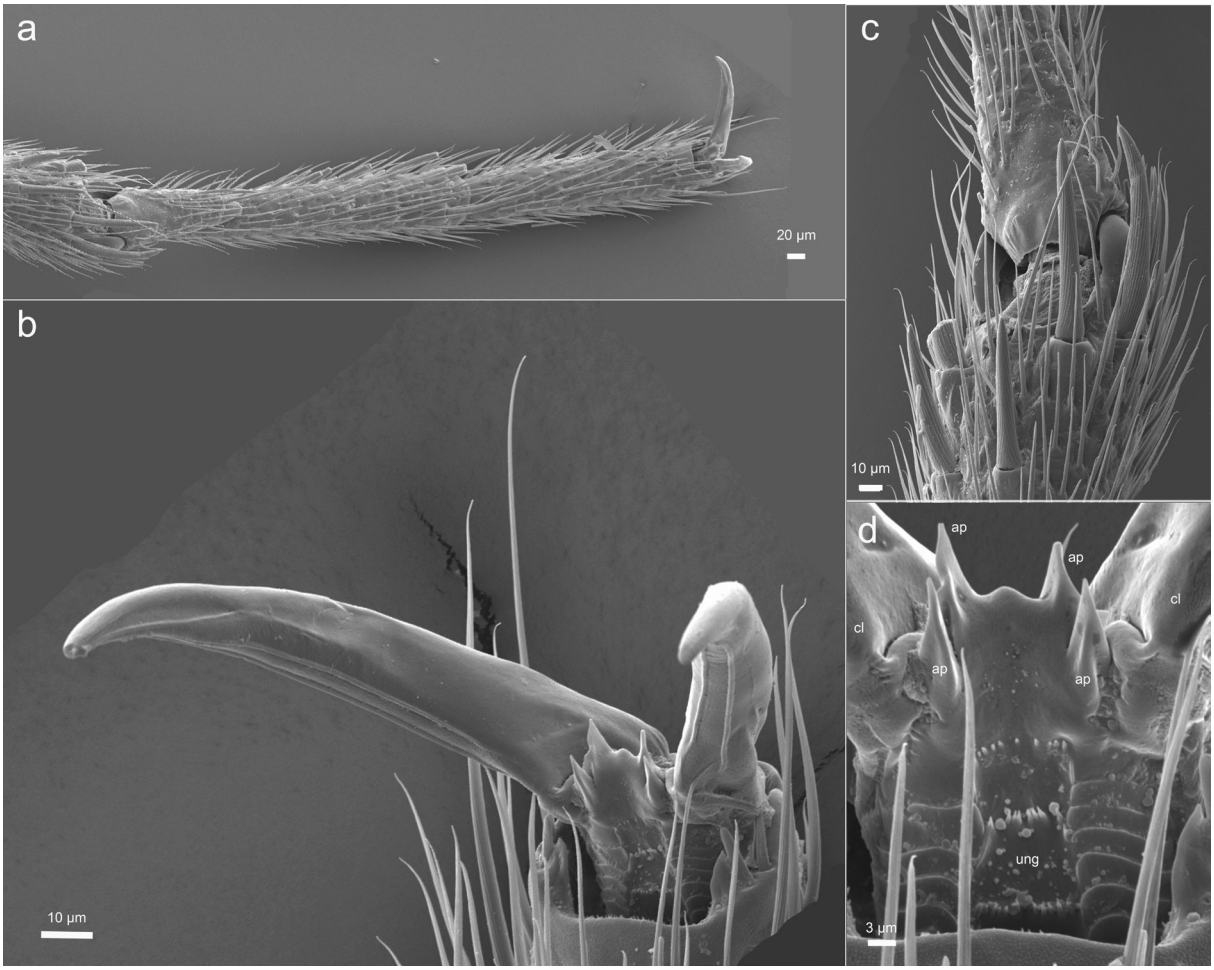


Plate fig. 84. Distal region of the hind leg of *Saldula saltatoria*. a – general view; b – distal tibia, ventral view; note the large fluted setae; c – pretarsus, ventral view; d – unguitractor region of a tarsus (different leg from the one in a-c); ap = accessory parempodia, cl = claw, ung = unguitractor; note the absence of microtrichia on the tarsal margin (in contrast to c, where microtrichia are visible).

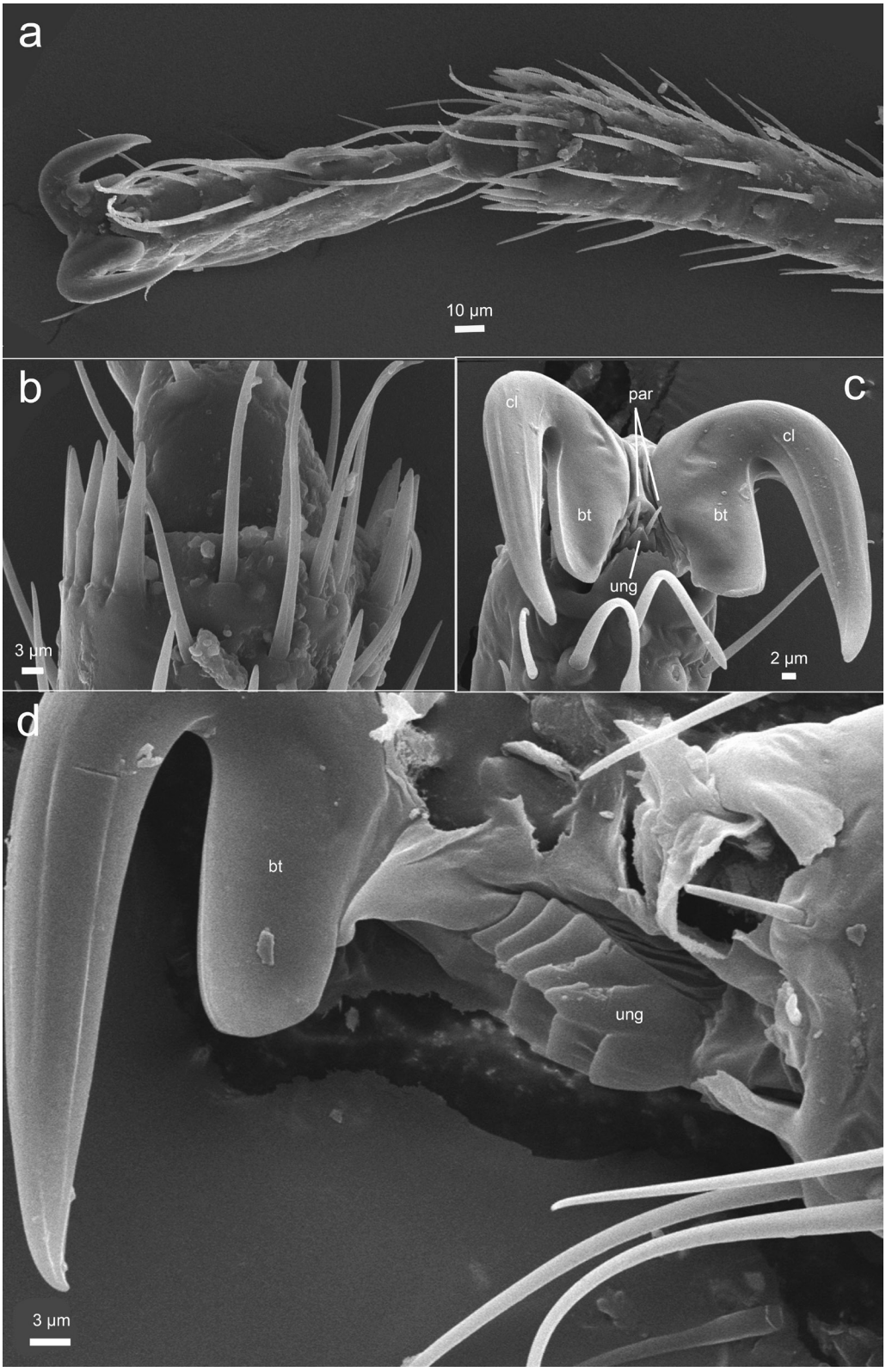


Plate fig. 85. Distal region of the leg of *Corythucha ciliata*. a – general view of the hind leg; b – distal hind tibia, ventral view; note the large fluted setae laterally; c – pretarsus of a fore leg, ventral view; bt = basal tooth of the claw; cl = claw, par = parempodia, ung = unguitractor; d – lateral view of a prepared hind pretarsus (different specimen than in a-c).

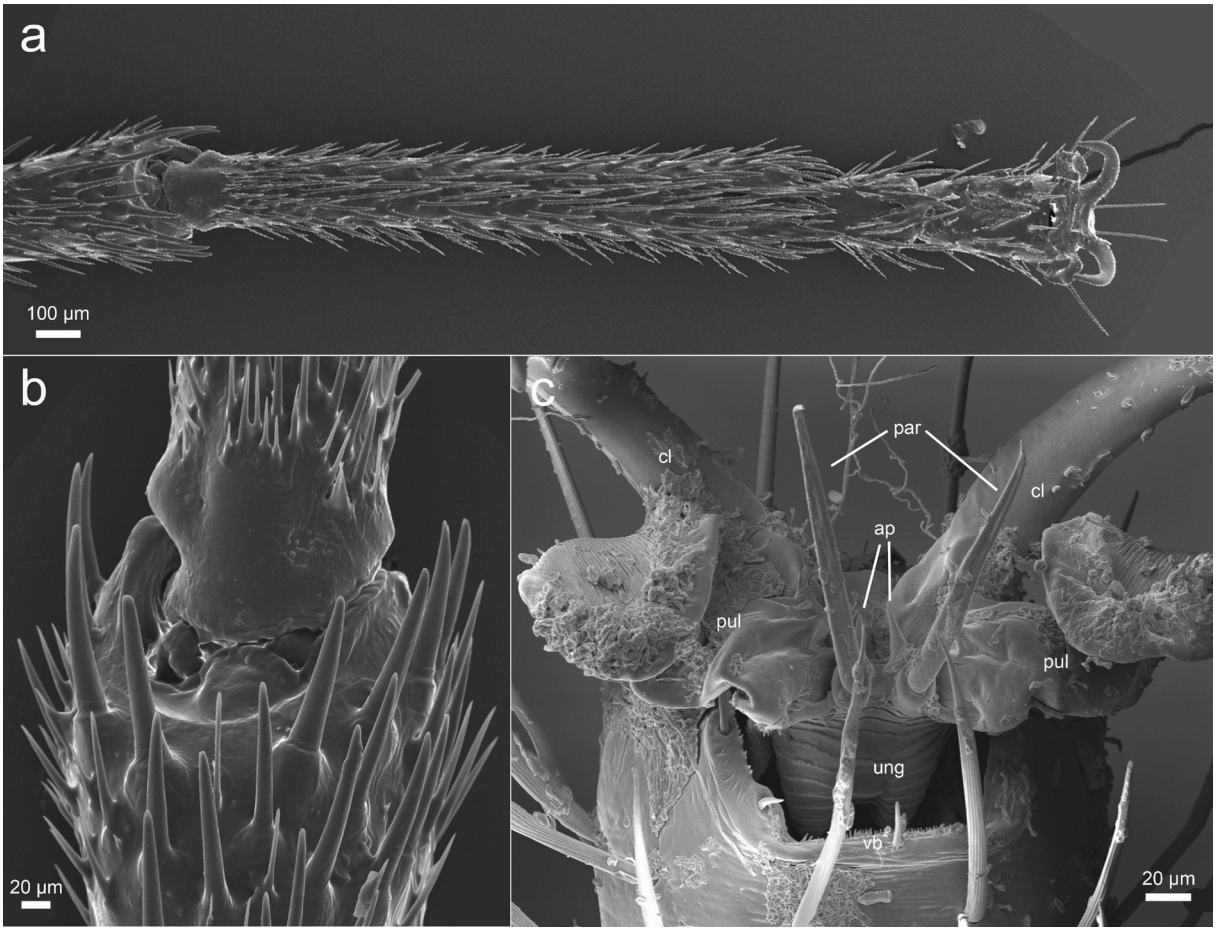


Plate fig. 86. Distal region of the hind leg of *Pyrrhocoris apterus*. a – general view; b – distal tibia, ventral view; c – pretarsus, ventral view (foretarsus, specimen different from the one in a and b); ap = accessory parempodia, cl = claw, par = parempodia, pul = pulvillus, ung = unguitractor, vb = ventral brush of microtrichia on distal margin of the last tarsal segment.

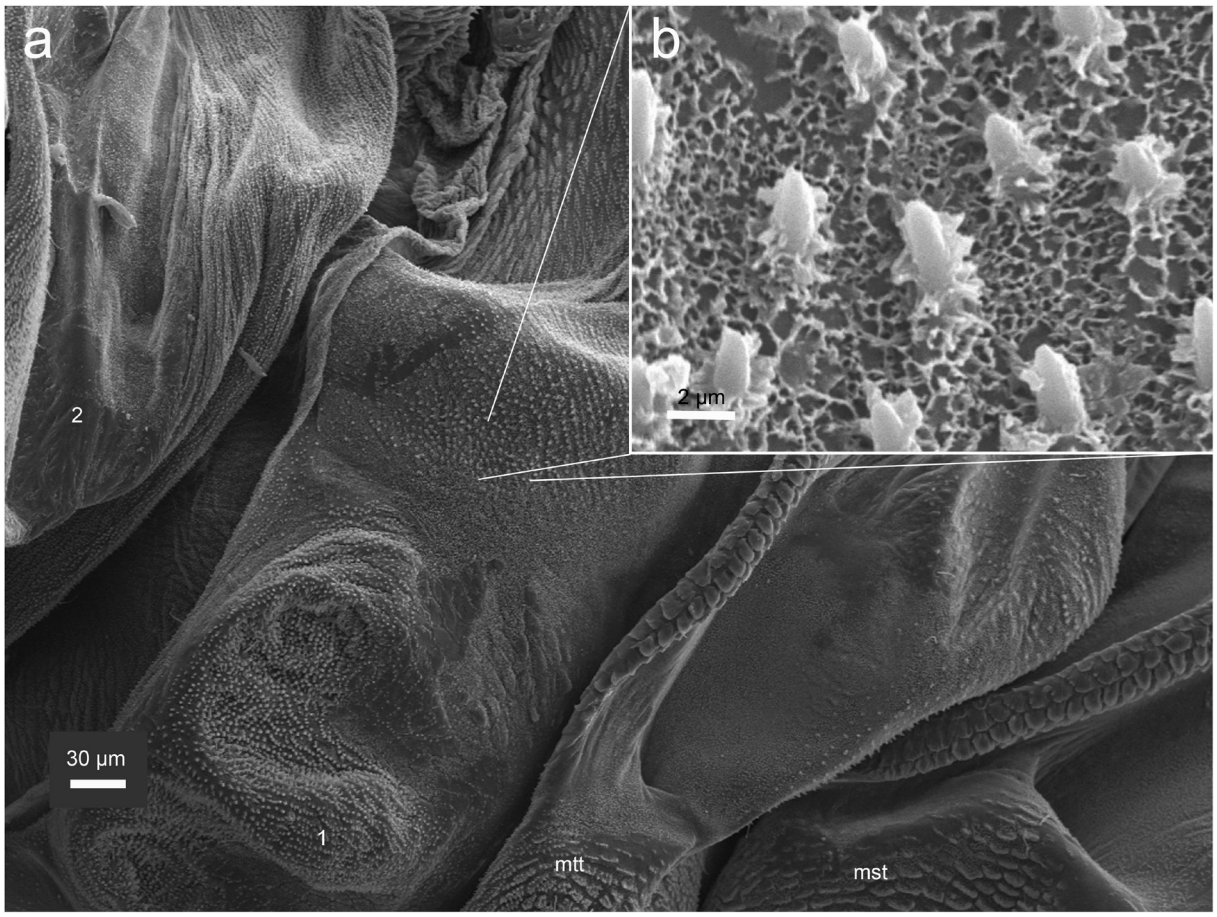


Plate fig. 87. Dorsal body surface in *Psylla alni*. a – general view; mst = mesothorax, mtt = metathorax, abdominal segments are numbered. b – a region on the first abdominal tergite in a, magnified; note microtrichia covered with wax-like secretion (removeable by incubation in chloroform).

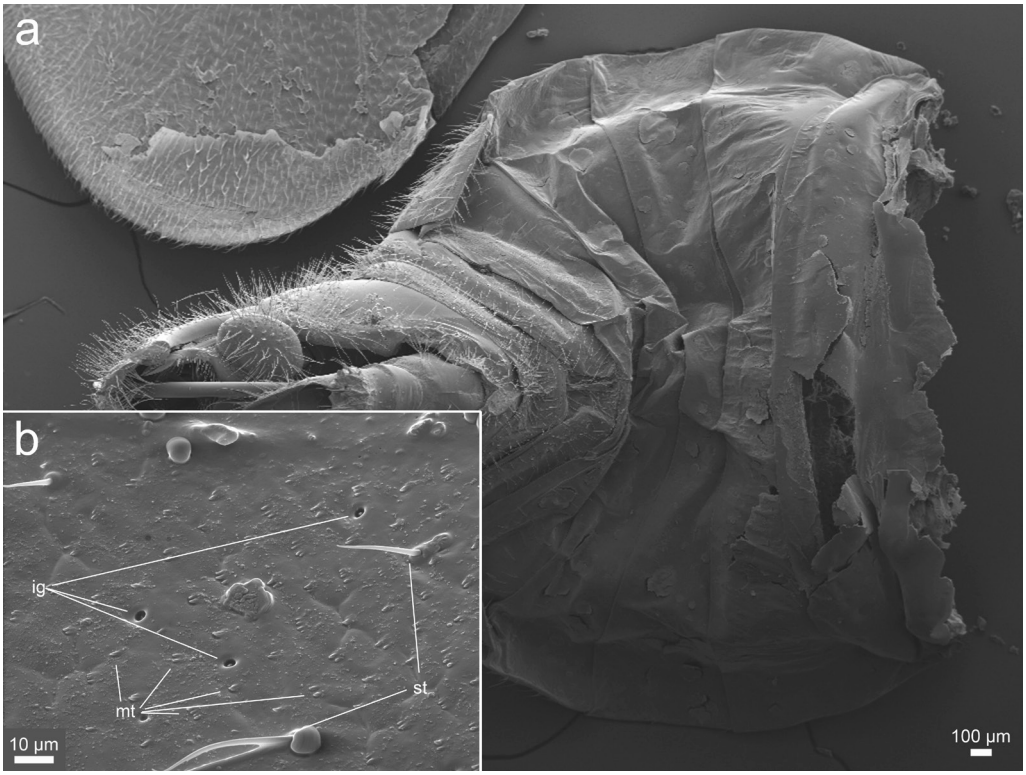


Plate fig. 88. Dorsal abdomen surface in *Cercopis sanguinolenta*. a – general view, b – a region on an abdominal tergite from a, magnified; ig = integumental glands, mt = microtrichia, st = sensilla trichodea. Note the sparse sculpture and absence of waxy secretion.

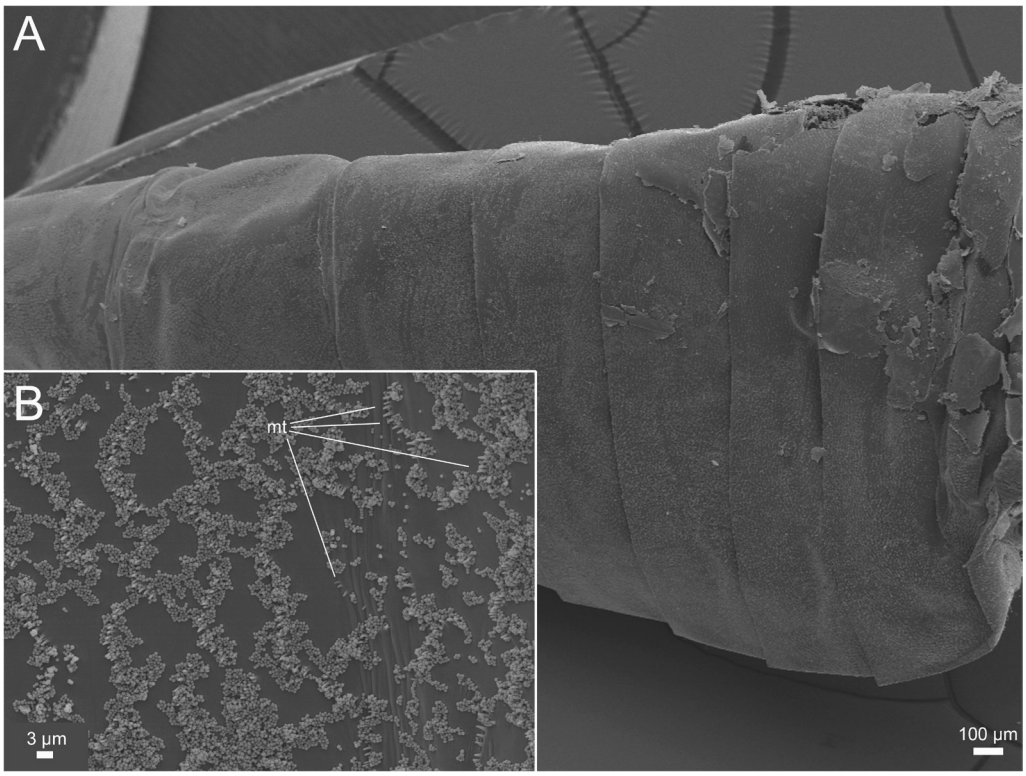


Plate fig. 89. Dorsal abdomen surface in *Cicadella viridis*. A – general view, B – a region from A, magnified. mt = microtrichia; the small particles covering most of the surface are brochosomes.

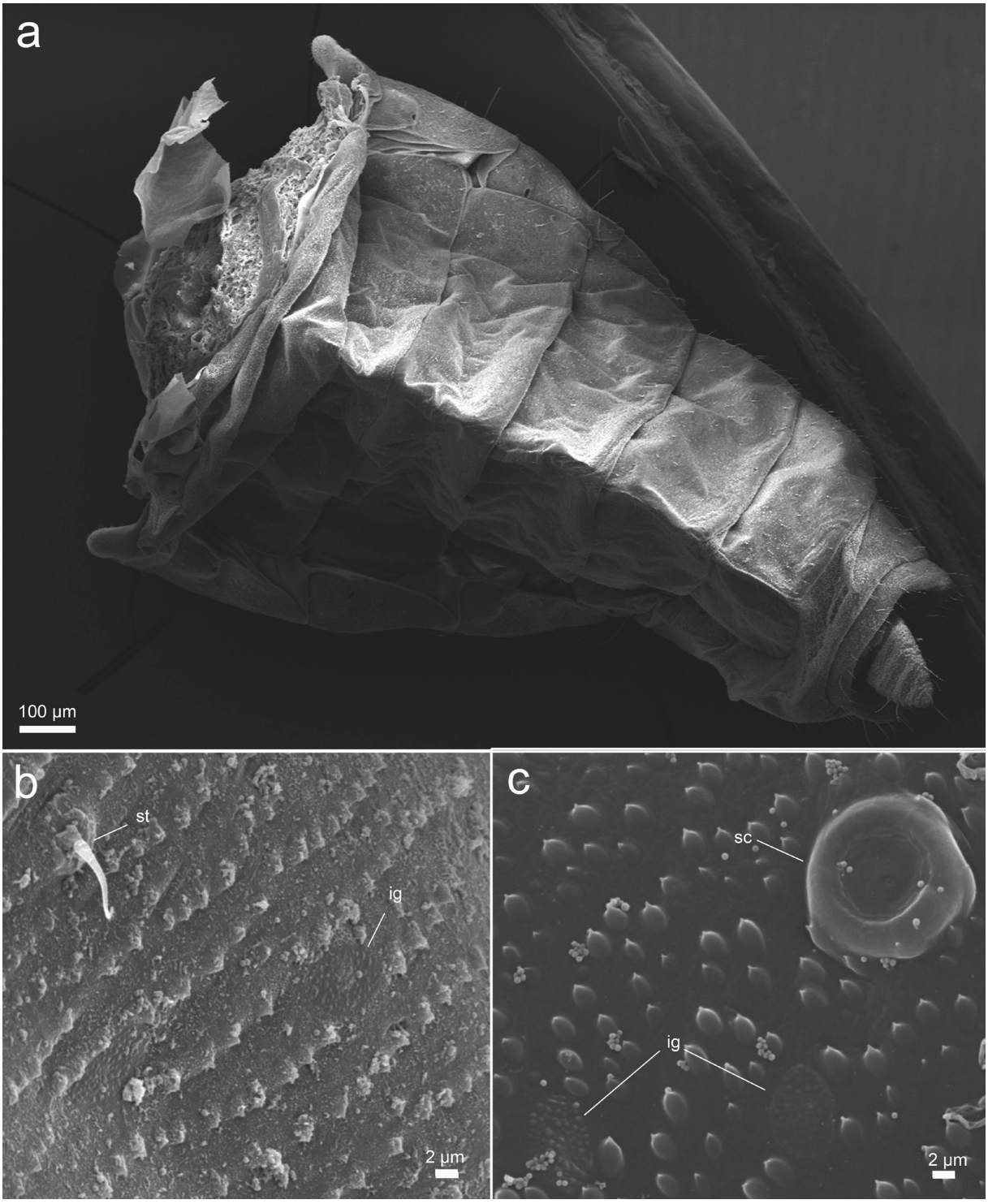


Plate fig. 90. Dorsal abdomen surface in *Laodelphax striatella*. a – general view in untreated specimen, covered in wax-like sceretion. b – a region of a, magnified; ig = integumental gland, st = sensillum trichodeum. c – a region of dorsal surface in a another specimen, incubated (dewaxed) in chloroform; ig = integumental gland, sc = sensillum campaniformium.

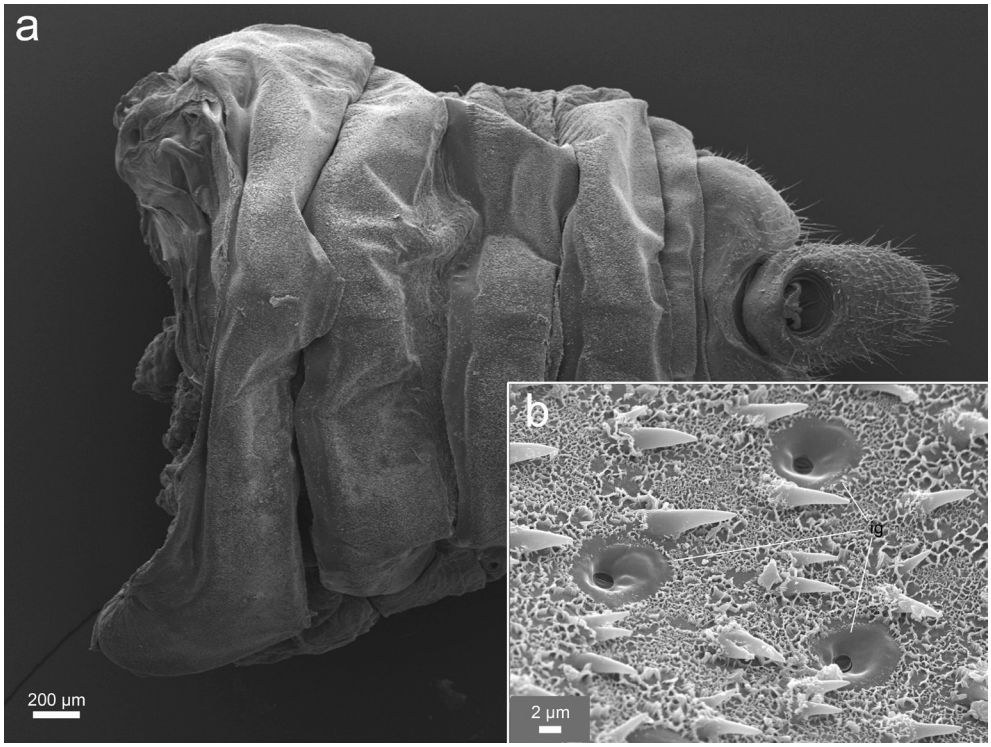


Plate fig. 91. Dorsal abdomen surface in *Issus coleoptratus*. a – general view. b – a region of a, magnified; ig = integumental glands. Note the wax-like secretion covering the abdomen.

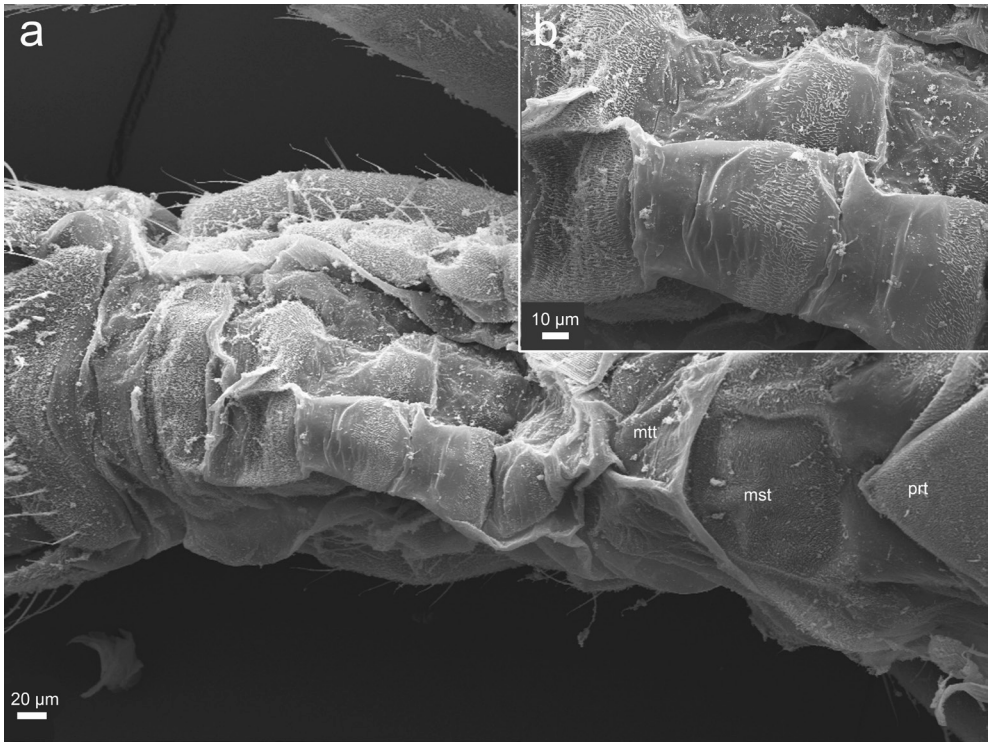


Plate fig. 92. Dorsal body surface in *Ceratocombus* sp. a – general view; mst = mesothorax, mtt = metathorax, prt = prothorax. b – a region of a, magnified. Note the small hair-like microtrichia. The debris pieces occurring everywhere are not wax, since a treatment in chloroform did not cause any changes.

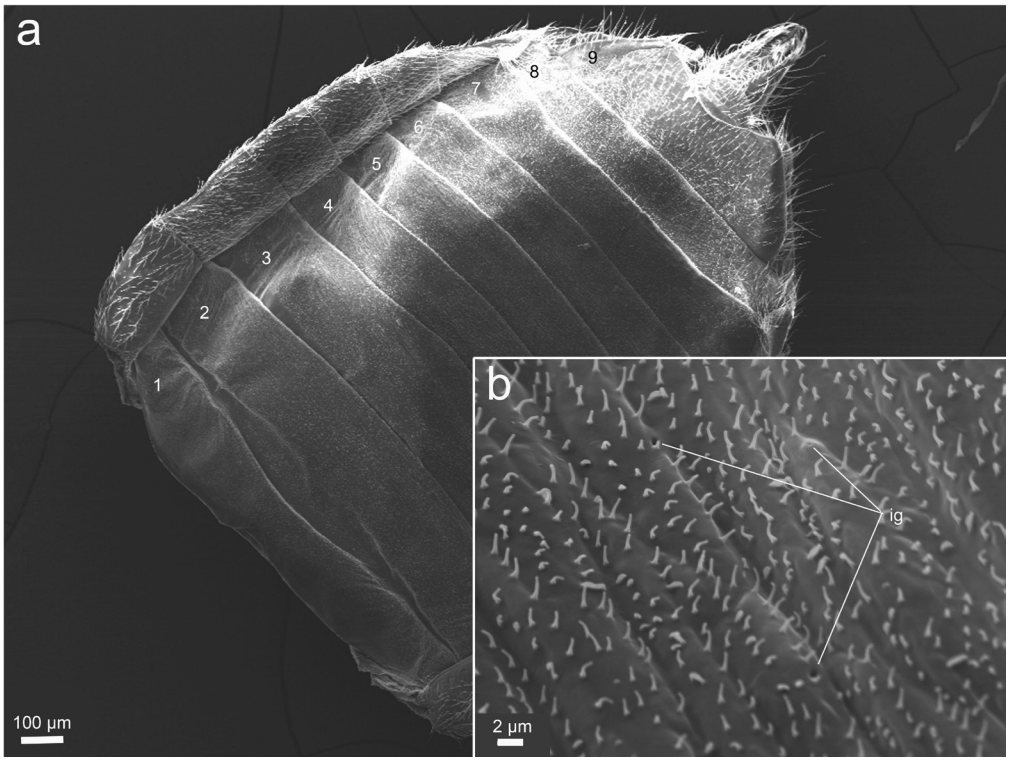


Plate fig. 93. Dorsal abdomen surface in *Saldula saltatoria*. a – general view; the abdominal segments are numbered. b – a region of a, magnified; ig = integumental glands. Note the absence of waxy secretion.

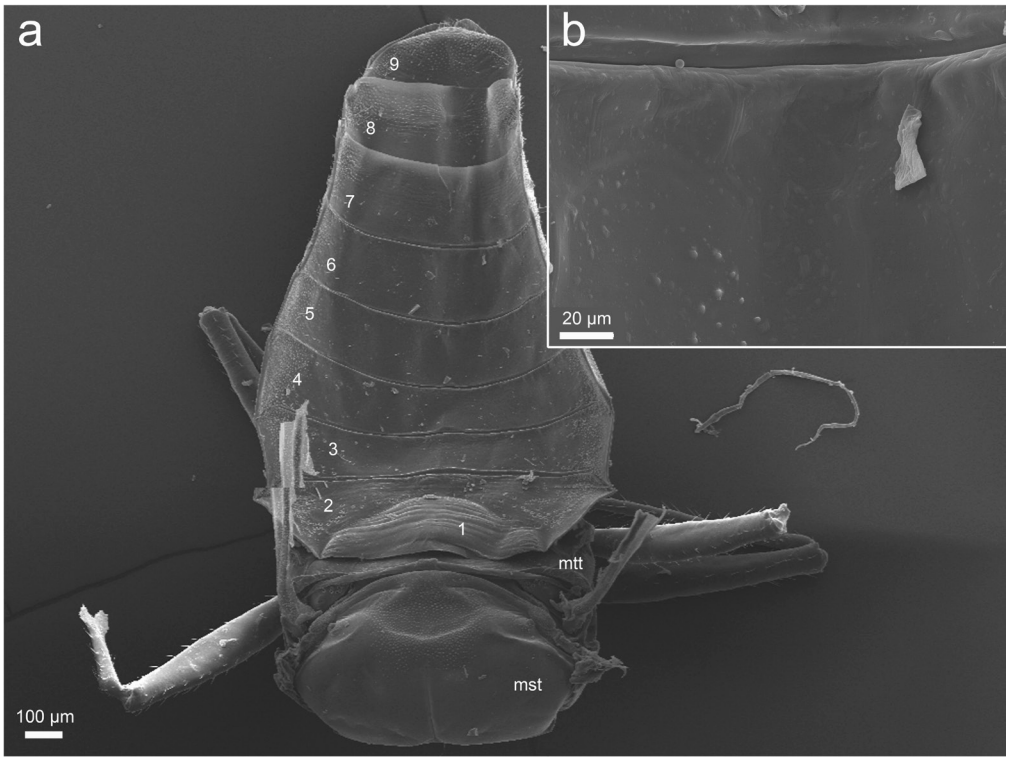


Plate fig. 94. Dorsal body surface in *Corythucha ciliata*. a – general view; mst = mesothorax, mtt = metathorax, abdominal segments are numbered. b – a region of a, magnified.

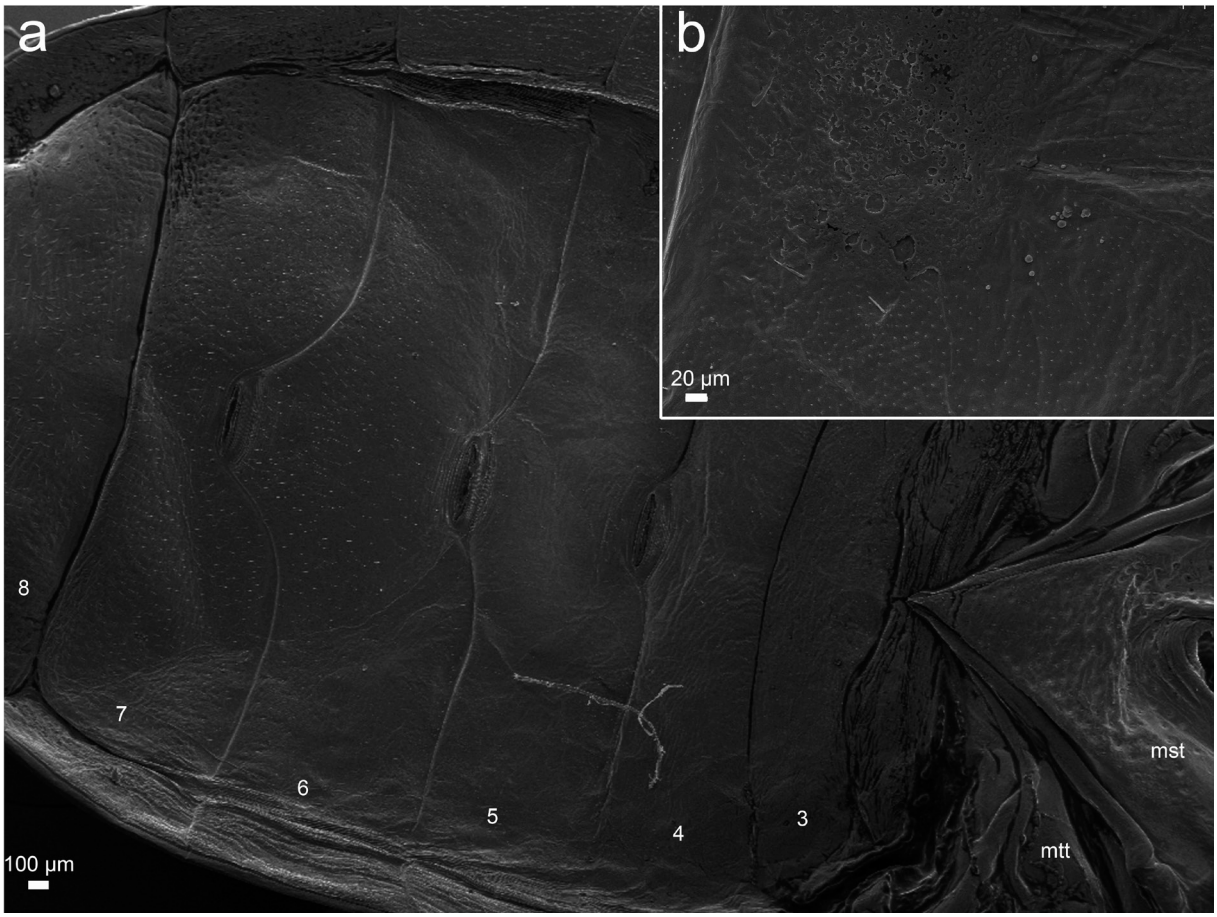


Plate fig. 95. Dorsal body surface in *Pyrrhocoris apterus*. a – general view; mst = mesothorax, mtt = metathorax, abdominal segments are numbered. b – a region of a, magnified; microtrichia and several trichoid sensilla are recognizable.

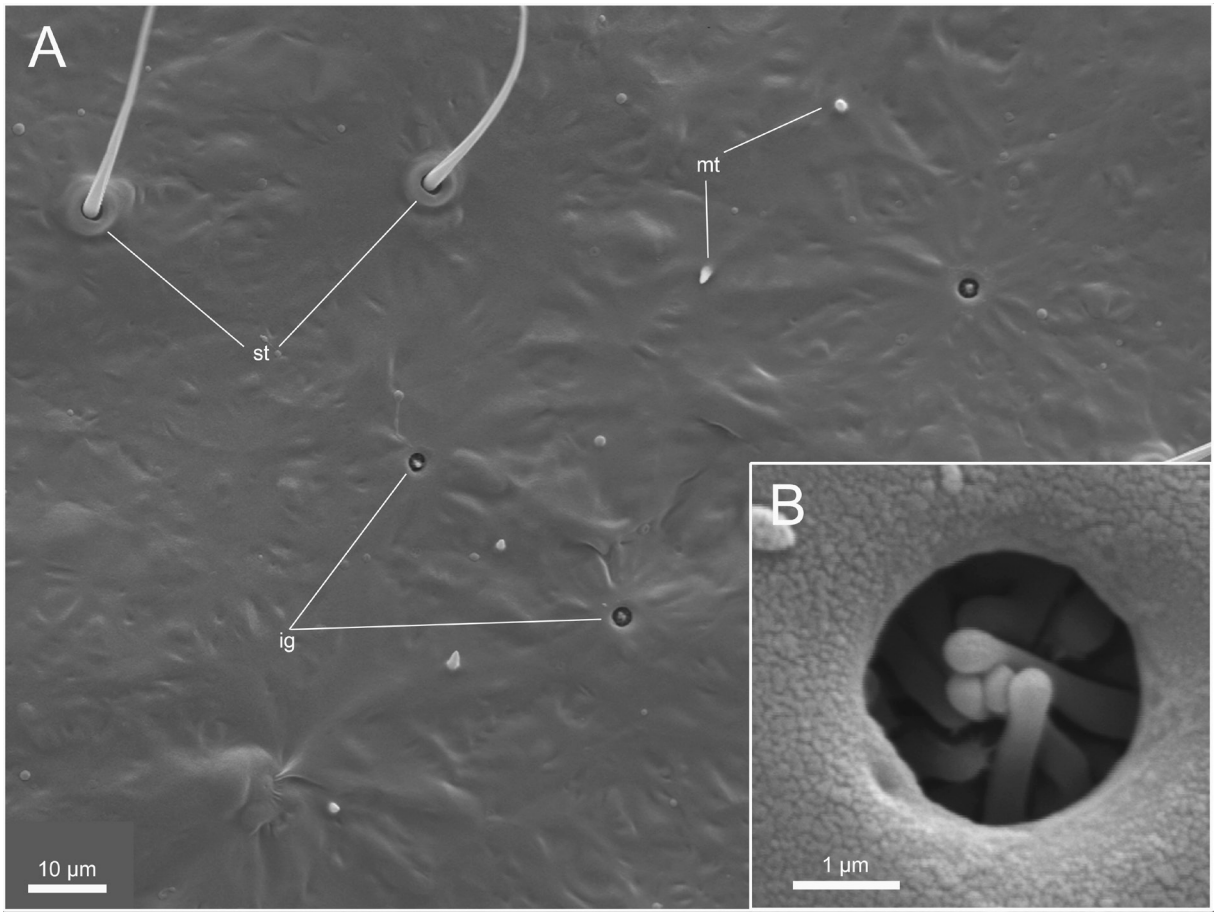


Plate fig. 96. Integumental glands in *Cercopis sanguinolenta*. A – fragment of the dorsal surface of the tegmen; ig = integumental glands, mt = microtrichia, st = sensilla trichodea. B – one of the integumental glands in A, magnified.

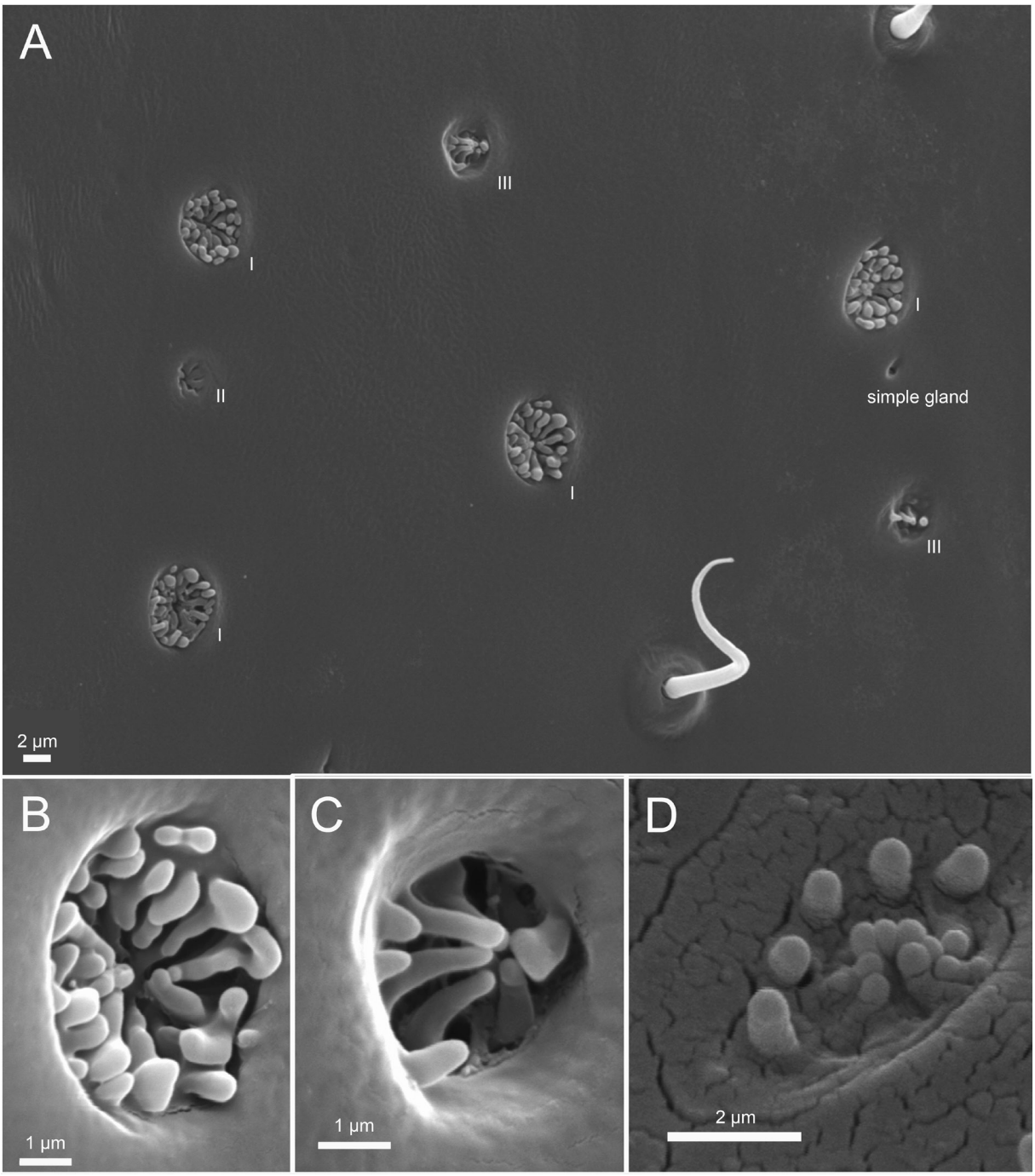


Plate fig. 97. Integumental glands in *Cicadella viridis*. A – a fragment of the surface of the head, with several types of the glands (I – III are the numbers as referred to in the text in Results section 3.3.2.4); B – gland of the type I, head; C – gland of the type III, head; D – gland of the type IV, abdominal tergite. A-C belong to a different specimen than D; the surface in A-C was treated with polymerizing agent to remove the brochosome covering.

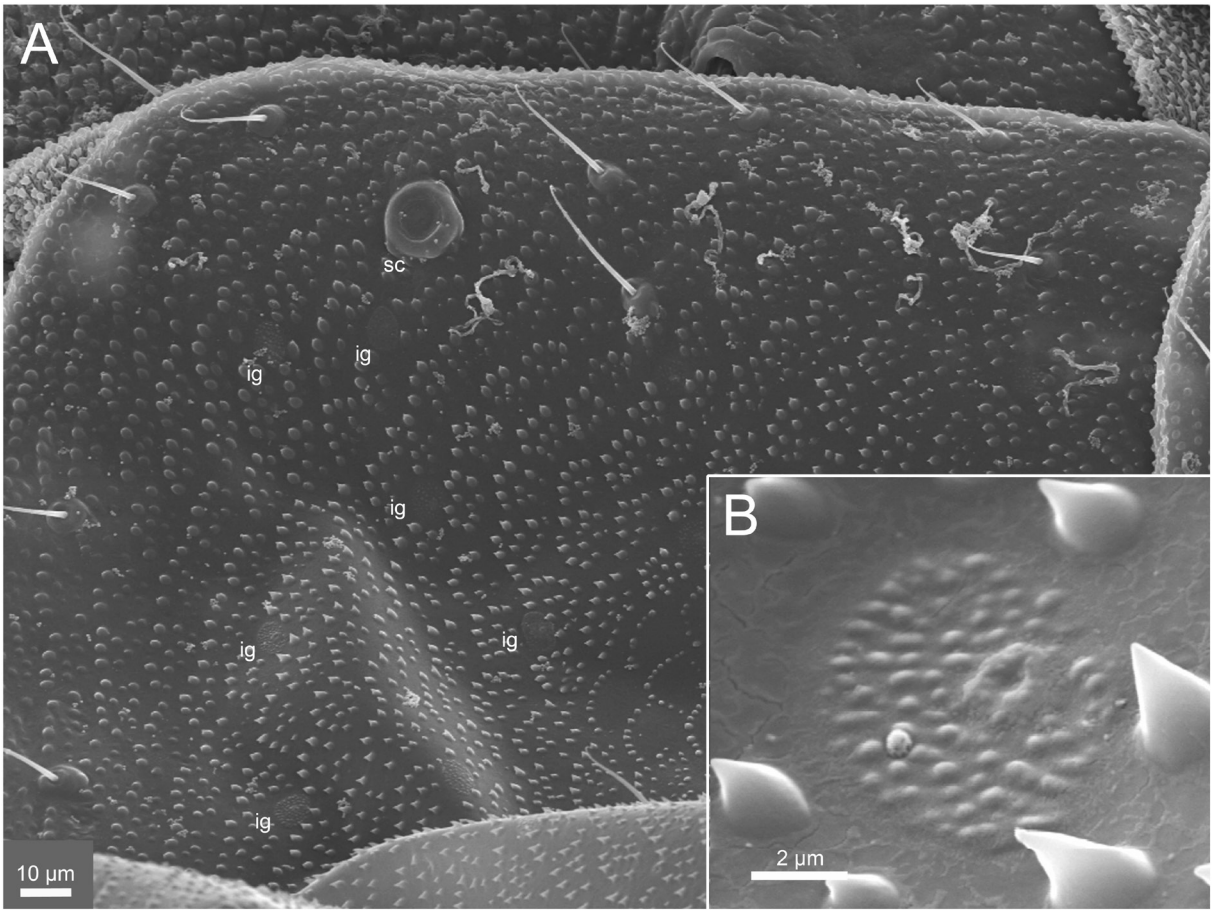


Plate fig. 98. Integumental glands in *Laodelphax striatella*. A – abdominal tergite 5., with some integumental glands (ig, mostly still covered by secretion), sensilla campaniformia (sc) and trichodea. B – one of the integumental glands from A, magnified.

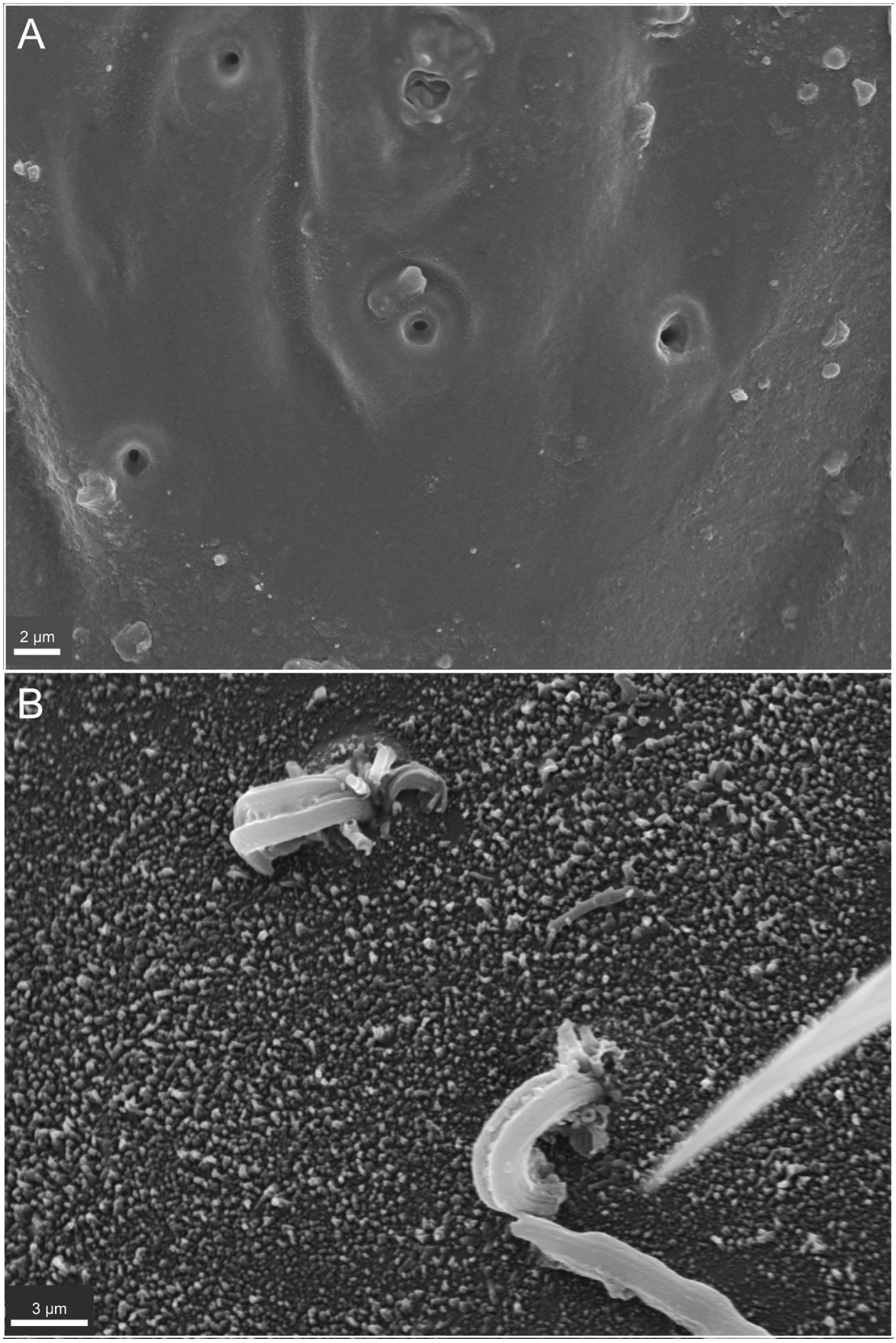


Plate fig. 99. Integumental glands on the head of *Issus coleoptratus*. A – several glands without secretion (specimen incubated in vinegar). B – two glands excreting wax filaments (specimen only briefly washed with detergent).

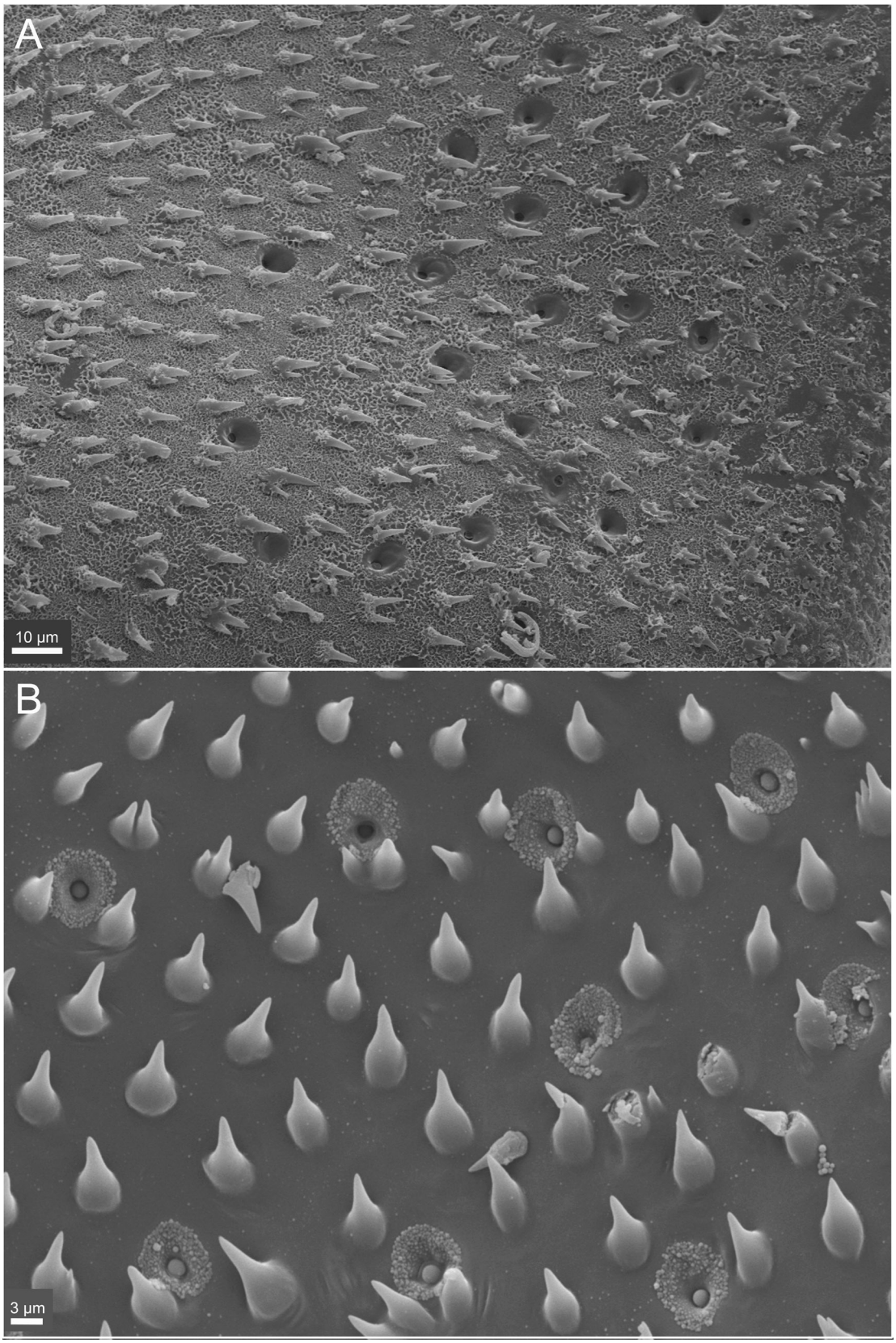


Plate fig. 100. Integumental glands on the abdominal tergites of *Issus coleoptratus*. A – in a specimen incubated in acetic acid (wax cover intact). B – in a specimen insubated in chloroform (wax cover removed).

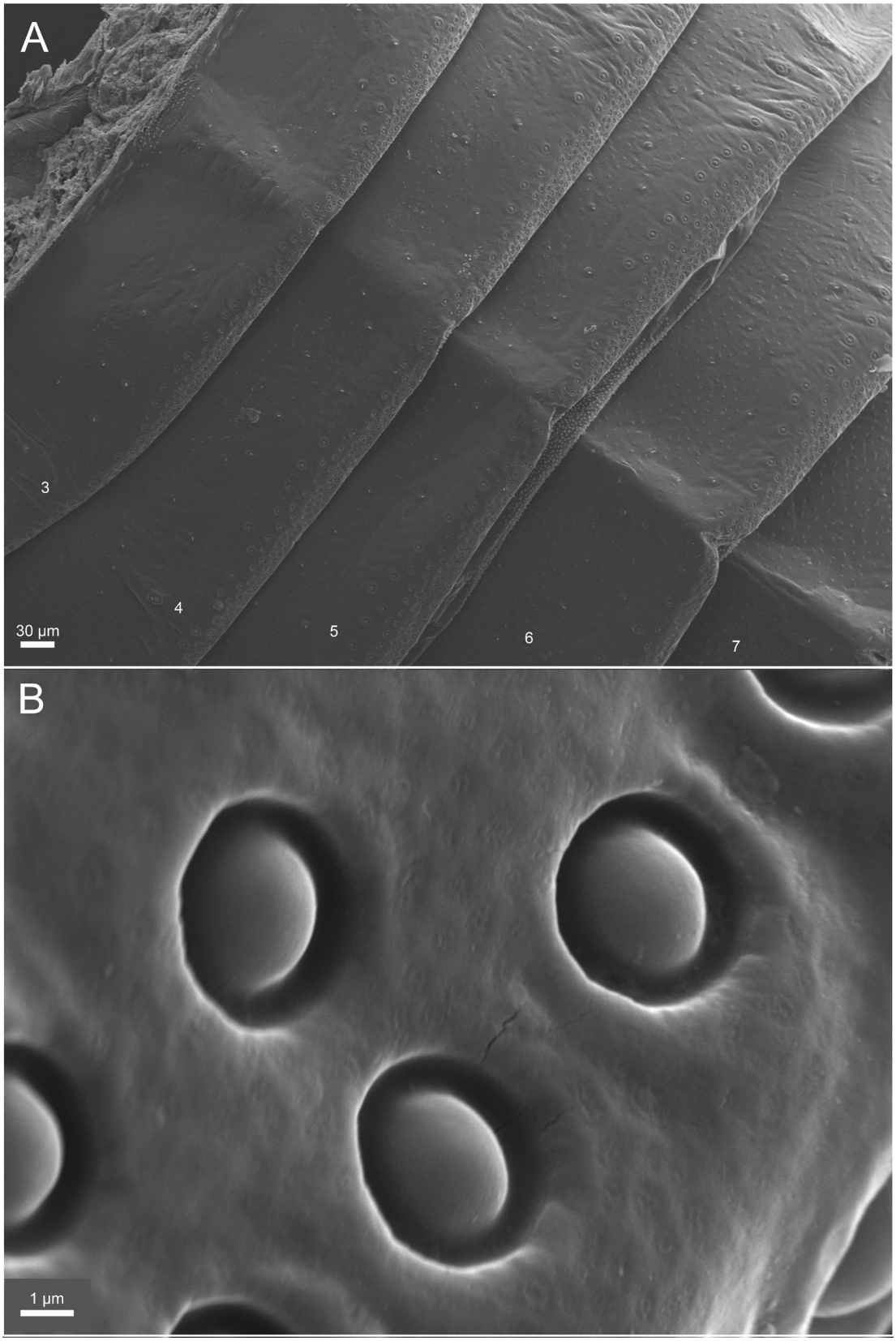


Plate fig. 101. Integumental glands in a larva of *Issus coleoptratus*. A – general view of the abdominal tergites (segments are numbered). B – several glands magnified.

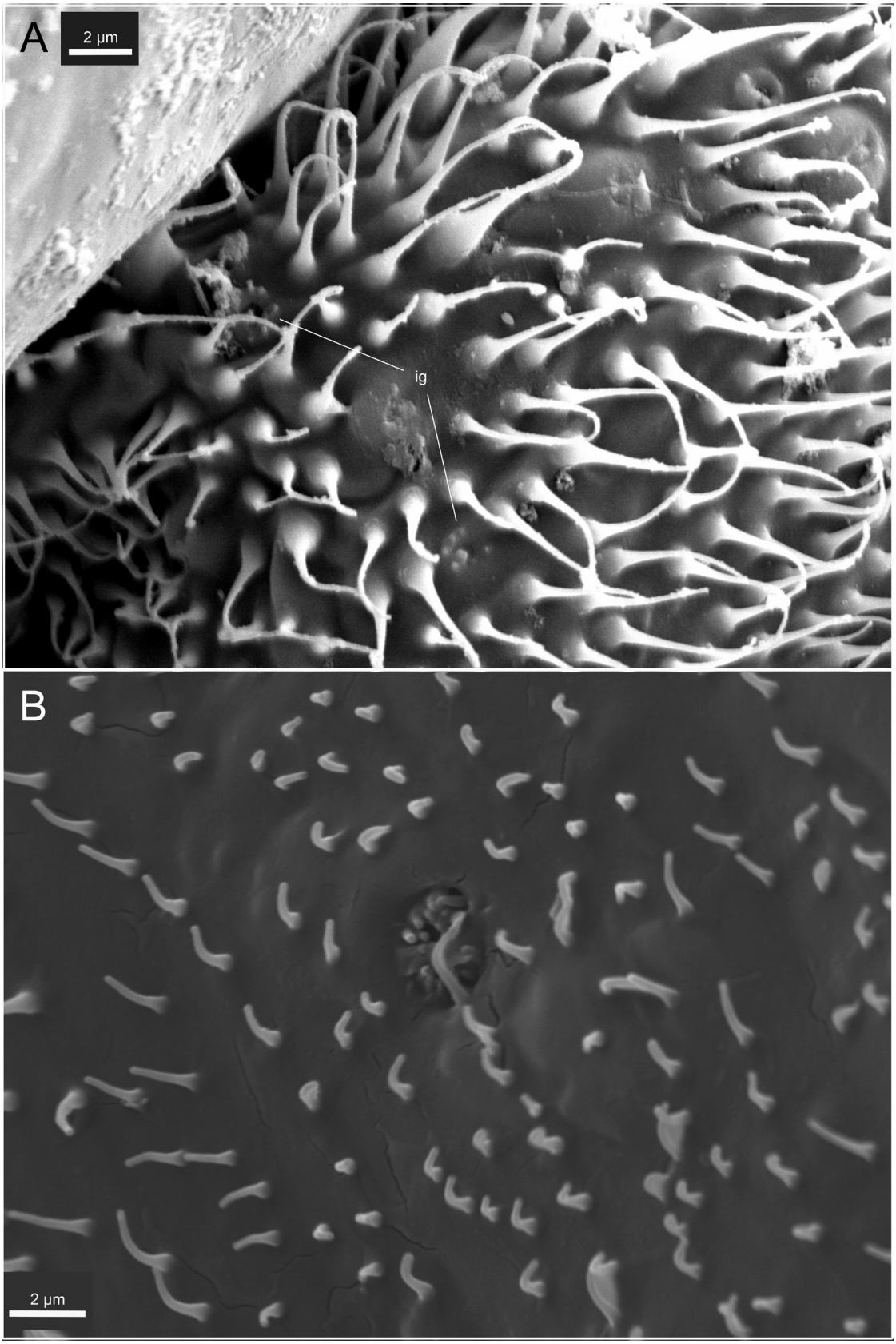


Plate fig. 102. Integumental glands in Heteroptera. A – *Ceratocombus* sp., a fragment of prosternum; ig = integumental glands. B – *Saldula saltatoria*, a fragment of abdominal sternum.

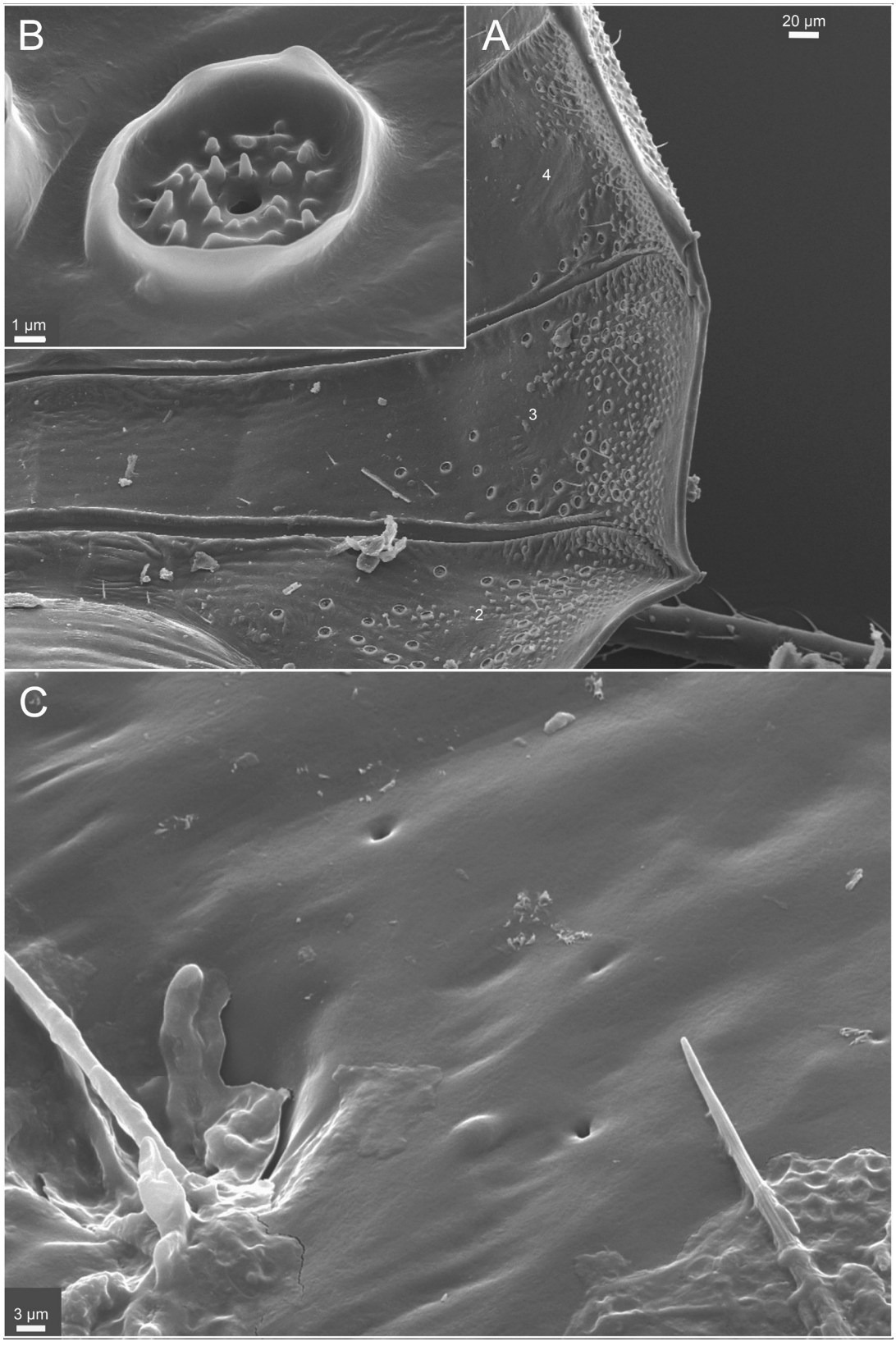


Plate fig. 103. Integumental glands in Heteroptera. A – general view of a dorsal side of *Corythucha ciliata*; the abdominal segments are numbered. Note the large circular glands in their lateral regions. B – an integumental gland of *Corythucha ciliata*, magnified. C – ventral side of the head of *Pyrrhocoris apterus*.

9 Supplement 1. Locations where Peloridiidae were collected

Field data on locations from where specimens of Peloridiidae were obtained are presented below (several other localities were sampled, but delivered no moss bugs and are not included here).

First, the geographical data on the location are provided (including coordinates and elevation). Then, the dates when the location was sampled are given; weather conditions are mentioned, too. After that follows a table with all the bryophyte species sampled in this locality. In its right column, the number of samples tested for each bryophyte species is given. When a sample did not deliver any peloridiids, it is marked as "-"; when it did, with the respective Peloridiidae species name (if adults were collected) or "larva(e)" when the species was not identifiable. A "+" between two species names or a species name and "larva(e)" means that the two species (or the species and the larvae) were obtained form the same sample. Different samples in the right column are separated by commas or semicolons; thus, the number of minuses and the species names that are separated by semicolons give the total number of times that the given bryophyte species was sampled in the given locality. For instance, "H. wil + H. acu" means that individuals of both *Hemiowoodwardia wilsoni* and *Hemiodoecus acutus* were present in the same sample of the bryophyte species from the left column; "H. wil; H. acu" means that the two peloridiids were present in two different samples of that bryophyte species that were collected on two different days etc. The respective dates whe the samples were collected are not given in the right column but are mentioned in the field notes.

The numbers of peloridiid specimens in the right column is based on the field notes that record the results of the extraction in Berlese funnels. Some of the specimens were lost in transportation or during laboratory cultivation, some were sent to colleagues for research (e.g. Küchler et al., 2013; Grozeva et al., 2014; Santos-Garcia et al., 2014; Kuznetsova et al., 2015) and some were used for scanning electron microscopy during this study (s. Supplement 4.). However, most of the specimens (including those used for SEM) are stored in the collection of the Natural History Museum in Berlin (Leibniz Institute for Evolution and Biodiversity Science), Germany.

Most of the bryophyte species that were tested were also collected as voucher samples for later identification. The samples are stored either at the collection of the Botanic Garden in Berlin, Germany, or at the Natural History Museum in Berlin, Germany. For some cases it is indicated that "no herbarium sample is left". That could happen with some of the easily recognizable bryophyte species; also, in cases of some Australian bryophytes, the herbarium samples were available to Elizabeth Brown (the late curator of the National Herbarium in Sydney, Australia) for the identification and then left at her disposal.

Abbreviations:

H. bra = *Hackeriella brachycephala*
H. ech = *Hackeriela echina*
H. vei = *Hackeriella veitchi*
H. fid = *Hemiodoecellus fidelis*
H. acu = *Hemiodoecus acutus*

H. cra = *Hemiodoecus crassus*
H. lea = *Hemiodeocus leai*
H. wil = *Hemiowoodwardia wilsoni*
O. abl. = *Oiophysa ablusa*
O. cum. = *Oiophysa cumberi*
O. dist. = *Oiophysa distincta*
P. dar = *Pantinia darwini*
P. ham = *Peloridium hammoniorum*
P. pom = *Peloridium pomponorum*
P. hol = *Peloridora holdgatei*
X. cas. = *Xenophyes cascus*
X. kin. = *Xenophyes kinlochensis*
X. rha. = *Xenophyes rhachilophus*
X. green. = *Xenophysella greensladeae*
X. stew. = *Xenophysella stewartensis*

Australia

QLD, Lamington NP, Mt Hobwee Summit

S 28° 15,228', E 153° 12,463'; elevation 1171 m. 10.11.2009 (weather: mostly overcast, sporadically sunny), 11.11.2009 (sunny), 12.11.2209 (overcast to sunny), 22.11.2009 (sunny), 23.11.2009 (overcast, but not rainy)

Bryophyte species	**Peloridiidae**
Bazzania cf. crassitexta[30]	3 larvae
Cyathophorum bulbosum	-
Dawsonia superba	-, -
Dicranoloma dicarpum	1 adult H. vei + 2 larvae
Dicranoloma menziesii	11 larvae; -
Isopterygium albescens	-
Lepidozia sp.	-
Papillaria crocea	-[31], -[32]

[30] Elizabeth Brown in her identification notes mentions that the herbarium sample also contained some *Balantiopsis diplophyllum*. This species is not visible on the field photos made on the spot and it is concluded that its amount was negligible.
[31] No herbarium sample left, but it was available to E. Brown at the moment of identification.

Papillaria flavolimbata[33]	-
Papillaria leuconeura[34]	-
Plagiochila baileyana	-
Plicanthus hirtellus	2 larvae
Ptychomnion aciculare	1 larva
Rosulabryum billarderi	-
Wijkia extenuata	-

QLD, Lamington NP, Mt Merino Lookout

S 28° 15,210', E 153° 11,656'; elevation 1106 m. 14.11.2009 (rainy), 16.11.2009 (sunny), 17.11.2009 (sunny to rainy), 21.11.2009 (sunny), 23.11.2009 (overcast, but not rainy)

Bryophyte species	**Peloridiidae**
Bazzania fasciculata	-
Calliergonella cuspidata	-
Dicranoloma dicarpum	1 larva; -[35]
Dicranoloma menziesii	1 larva; -[36]
Dicranoloma robustum	-, -[37]
Echinodium hispidum	-
Lepidozia multifida	-
Papillaria leuconeura	-[38]
Papillaria sp.	-[39]
Plicanthus hirtellus	-
Pyrrhobryum parramattense	-, -[40]
Thuidiopsis sparsa	-
Trachyloma planifolium	-
Weymouthia cochlearifolia	-

Leaf litter: sifted on 16.11.09 – 5 larvae.

[32] ID is somewhat uncertain; no herbarium sample is left from the respective date, but the herbarium sample of the same species collected on another day was identified by E. Brown as *P. crocea*.
[33] No herbarium sample left, but it was available to E. Brown at the moment of identification.
[34] No herbarium sample left, but it was available to E. Brown at the moment of identification.
[35] Certainly a *Dicranoloma,* although no herbarium sample left (was available to E. Brown).
[36] No herbarium sample left (was available to E. Brown).
[37] No herbarium sample left (was available to E. Brown); also, the reason for this sample not to provide any Peloridiidae specimens was probably a long storage of the sifted material before the analysis in Berlese funnels.
[38] No herbarium sample left, but other herbarium sample of the same species was identified as *P. leuconeura.*
[39] No herbarium sample left (was available to E. Brown), collected in the same sample with *Papillaria crocea*.
[40] No herbarium was taken for this sample; ID based solely on field experience.

QLD, Lamington NP, "2 Nothofagus"

S 28° 14,922', E 153° 10,752'; elevation 1111 m. 19.11.2009 (sunny)

Bryophyte species	Peloridiidae
Bazzania adnexa	several larvae
Cyathophorum bulbosum	-

Leaf litter: sifted on 19.11.09 – 1 larva

QLD, Lamington NP, Wanungara Lookout

S 28° 15,251', E 153° 10,564'; elevation 1167 m. 19.11.2009 (sunny)

Bryophyte species	Peloridiidae
Camptochaete arbuscula	-
Dicranoloma menziesii	1 larva
Lepidozia ulothrix	several larvae
Pyrrhobryum parramattense	1 adult H. vei
Wijkia extenuata	2 adult H. ech + several larvae

Leaf litter: sifted on 19.11.09 – several larvae and an adult *H. veitchi*

QLD, Lamington NP, "Unknown Lookout"

S 28° 15,388', E 153° 11,914'; elevation 1043 m. 23.11.2009 (overcast, but not rainy)

Bryophyte species	Peloridiidae
Wijkia extenuata	2 larvae

NSW, New England NP, Eagle's Nest track

S 30° 29,383', E 152° 24,579'; elevation 1479 m. 03.12.2009 (sunny), 05.12.2009 (changeable, rainy now and then), 06.12.2009 (misty, but not rainy), 07.12.2009 (sunny), 12.12.2009 (strong mist, sometimes separate raindrops, but not really rainy)

Bryophyte species	**Peloridiidae**
Atrichum androgynum	1 adult H.bra + 1 larva
Breutelia pendula	-
Camptochaete arbuscula	2 larvae
Dicranoloma dicarpum	4 adult H. bra + 5 larvae; - ; -
Dicranoloma sp.	-
Dicranoloma sp.	-
Lepidozia multifida	3 larvae
Papillaria flavolimbata	1 larva[41]
Papillaria leuconeura	-
Parmelia sp.[42]	-
Plagiochila fasciculata	-
Wijkia extenuata	-, -[43]

Leaf litter: sifted on 03.12.09 – 2 adult *H. brachycephala*, 7 larvae

Leaf litter: sifted on 12.12.09 – 3 adult *H. brachycephala*, 3 larvae

NSW, New England NP, "Carpark"

S 30° 29,497', E 152° 24,360'; elevation 1441 m. 07.12.2009 (sunny)

Bryophyte species	**Peloridiidae**
Dicranoloma sp.[44]	1 adult H. bra+ 12 larvae
Lepidozia sp.[44]	-

[41] The sample also contains other bryophytes, e.g. *Isopterygium*, even if *Papillaria* makes the bulk of it. Maybe these admixtures of other species are the reason why Peloridiidae were obtained from the sample (since in all other cases when *Papillaria* species were analyzed they did not deliver any moss bugs).
[42] A lichen; Drake & Salmon (1948, 1950) report Peloridiidae funds from lichens in New Zealand.
[43] No herbarium sample, but the species is unmistakable.
[44] No herbarium sample left, thus only identification to genus possible (with photos from the location).

Leaf litter: sifted on 07.12.09 – 1 adult *H. brachycephala* and 1 larva

NSW, New England NP, Wright's Lookout

S 30° 30,406; E 152° 24,253; elevation 1253 m. 10.12.2009 (mostly sunny, but with an occasional short rain), 11.12.2009 (sunny, but it rained the night before)

Bryophyte species	**Peloridiidae**
Dicranoloma dicarpum	-
Dicranoloma sp.	-[45]
Lepidozia sp.	3 larvae[45]
Thamnobryum pumilum	-
Wijkia extenuata	-

Leaf litter: sifted on 10.12.09 and 11.12.09 – in both cases no Peloridiidae

NSW, Kosciuszko NP, Rennix Gap

S 36° 21,599', E 148° 30,482'; elevation 1566 m. 18.12.2009 (the night before rainy, morning overcast, afternoon sunny), 19.12.2009 (sunny), 21.12.2009 (sunny), 22.12.2009 (sunny), 27.12.2009 (sunny to overcast)

Bryophyte species	**Peloridiidae**
Aulacomnium palustre	-
Breutelia pendula	-
Sphagnum cristatum	2 adult H. lea + 4 larvae[46]
Sphagnum sp.	10 adult H. lea + 35 larvae[47]; 1 larva[47]; -

NSW, Kosciuszko NP, Sawyers' Hill

S 35° 53,781', E 148° 32,082'; elevation 1372 m. 26.12.2009 (overcast, misty, but without rain)

[45] No herbarium sample left, thus only identification to genus possible (with photos from the location).
[46] No herbarium sample from this date, but the same species from the same location collected the next day was identified as *S. cristatum*.
[47] No herbarium sample left.

Bryophyte species	Peloridiidae
Rosulabryum torquescens	-
Sphagnum cristatum	5 adult H. cra + 1 larva

VIC, Yara Ranges NP, Cement Creek

S 37° 42,581', E 145° 42,264'; elevation 705 m. 01.01.2010 (overcast to rainy), 03.01.2010 (overcast and moist, but not rainy), 04.01.2010 (sunny), 05.01.2010 (sunny)

Bryophyte species	Peloridiidae
Achrophyllum dentatum	-
Atrichum androgynum	-
Balantiopsis diplophyllum	-
Bazzania adnexa	1 larva; -[48]; -[48]
Camptochaete sp.	-
Dicranoloma menziesii	-, -
Hypnodendron sp.	-
Plagiochila strombifolia	-
Ptychomnion aciculare	-
Wijkia extenuata	1 larva[49]; -[49]

Leaf litter: sifted on 01.01.2010 and 03.01.2010, in both cases without success.

VIC, Yara Ranges NP, Mt. Donna Buang

S 37° 41,909', E 145° 41,483'; elevation 1093 m. 06.01.2010 (sunny)

Bryophyte species	Peloridiidae
Lepidozia sp.	-[50]
Wijkia extenuata	-[51]

[48] No herbarium sample or photos left, identification based on field experience.
[49] No herbarium sample of the host moss or its photos left, but the species is unmistakable.
[50] No herbarium or photos left, but the genus is unmistakable.
[51] No herbarium or photos left, but the species is unmistakable.

Leaf litter: sifted on 06.01.2010 – 1 adult *H. leai* + 2 larvae

VIC, Great Otways NP, Mait's Rest

S 38° 45,258', E 143° 33,346'; elevation 217 m. 08.01.2010 (sunny), 09.01.2010 (sunny), 11.01.2010 (sunny), 13.01.2010 (changeable, but not rainy; it rained the day before), 17.01.2010 (sunny to rainy), 21.01.2010 (sunny to rainy)

Bryophyte species	**Peloridiidae**
Bazzania adnexa	-[52]
Camptochaete deflexa	10 larvae
Camptochaete sp.	-
Dicranoloma menziesii	-[52], -
Hymenophyton flabellatum	1 adult H. acu
Hypnum chrysogaster	-
Lepidozia septemfida	-
Leucobryum candidum	3 adult H. wil
Lopidium concinnum	5 larvae
Papillaria flavolimbata	-
Plagiochila strombifolia	-
Ptychomnion aciculare	-
Symphyogyna podophylla	-
Trichocolea mollissima	-, -
Tylimanthus tenellus	-
Weymouthia mollis	-
Wijkia extenuata	1 adult H. wil; -

Leaf litter: sifted on 09.01.10 – 2 adult *H. wilsoni* + 1 larva; sifted on 17.01.10 – 1 adult *H. wilsoni*. Sifted on 08.01.2010 and 11.01.2010 without success.

VIC, Great Otways NP, Beauchamp Falls

S 38° 38,859', E 143° 36,708'; elevation 291 m. 14.01.2010 (overcast), 22.01.2010 (quite overcast, but with only few raindrops)

[52] No herbarium sample or photos, identification based on field experience

Bryophyte species	Peloridiidae
Adelanthus bisetulus	-
Balantiopsis diplophyllum	1 larva
Bazzania adnexa	-[53]
Dicranoloma menziesii	-[53]
Hypnodendron spininervium	-
Leucobryum candidum	-
Lopidium concinnum	-
Podomitrium phillanthus	-
Ptychomnion aciculare	2 adult H. wil + 1 larva
Rhizogonium distichum	1 larva
Rosulabryum billarderi	-
Rosulabryum subtomentosum	2 adult H. acu + 1 adult H. wil
Trichomanes venosum[54]	-
Wijkia extenuata	1 adult H. acu + 1 adult H. wil + 5 larvae[55]

Leaf litter: sifted on 14.01.10 – 1 adult *H. acutus*, 2 adult *H. wilsoni*, 4 larvae

VIC, Great Otways NP, Little Aire Falls track

S 38° 40,219', E 143° 30,338'; elevation 273 m. 23.01.2010 (sunny)

Bryophyte species	Peloridiidae
Fissidens oblongifolius	-
Kindbergia praelonga	1 adult H. acu + several larvae

VIC, Great Otways NP, Triplet Falls

S 38° 40,234', E 143° 29,648'; elevation 326 m. 18.01.2010 (rainy), 23.01.2010 (sunny)

Bryophyte species	Peloridiidae
Bazzania adnexa	-
Lepidozia sp.	-[56]

[53] No herbarium sample or photos, identification based on field experience.
[54] A filmy fern (f. Hymenophyllaceae). Without photos or herbarium sample, identification based on field experience in Yarra Ranges NP where the species was identified.
[55] Only photos of the bryophyte sample available, but the species is unmistakable.

Leucobryum candidum	1 larva
Schistochila lehmanniana	4 adult H. acu + 1 H. wil + 2 larvae; 1 adult H. acu
Wijkia extenuata	1 adult H. acu[57]

TAS, Wellington Park Reserve, O'Grady's Falls

S 42° 54,606', E 147° 15,223'; elevation 453 m. 03.02.2010 (overcast)

Bryophyte species	**Peloridiidae**
Bartramia compacta	1 larva[58]
Bazzania adnexa	1 adult H. lea
Catagonium nitens	-
Chiloscyphus limosus	1 adult H. lea + 4 larvae[59]
Dicranoloma robustum	-
Lepidozia multifida	-
Ptychomnion aciculare	1 H. lea[60]
Wijkia extenuata	-

TAS, Mt. Field NP, Russel Falls

S 42° 40,608', E 146° 42,690'; elevation 203 m. 29.01.2010 (sunny), 31.01.2010 (sunny)

Bryophyte species	**Peloridiidae**
Hypnodendron vitense	3 adult H. lea
Leucobryum candidum	24 adult H. fid + 34 larvae[61]
Ptychomnion aciculare	-
Wijkia extenuata	-

[56] No herbarium sample left, but the genus is unmistakable.
[57] No herbarium sample left, but the species is unmistakable.
[58] Too young, not identifiable.
[59] One fifth instar (*H. leai*), another three too young and unidentifiable.
[60] No herbarium material or photos, but the species is unmistakable.
[61] Only three are 5th instars that can be identified (*H. fidelis*), the rest is too young.

Chile

In several cases during the collecting in Chile it was not feasible to collect bryophyte species separately, or sometimes the goal was only to gather as many Peloridiidae specimens as possible. In such cases large amounts of different bryophyte species (called "mixes" in the notes) were taken; most of such cases are not considered in the tables below (except for cases when no moss bugs were obtained – then all the bryophyte species that were found in the "mix" are included in the respective table for the locality as "-").

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin, Pichihuillilemu

S 41°52.953', W 73°40.031', elevation -16m. 26.01.2014 (overcast to sunny), 31.01.2014 (changeable, but not rainy), 01.02.2014 (rainy)

Bryophyte species	**Peloridiidae**
Arbusculohypopterygium arbuscula	-
Dicranoloma billarderii	-, -
Dicranoloma robustum	-
aff. *Polytrichadelphus magellanus*	1 adult P. ham + 1 larva[62]; 3 adult P. ham + several larvae[63]
Plagiochila lophocoleoides	-
Plagiochila stictaecola	-
Ptychomnion cygnisetum	-
Sphagnum falcatulum	9 adult P. pom + 16 larvae[64]; 1 adult P. ham + 5 adult P. pom + 17 larvae[35]; 5 adult P. pom

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin, Ribereño

S 41°53.177', W 73°40.499', elevation 30m. 30.01.2014 (strong rain in the morning, overcast in the afternoon), 02.02.2014 (mostly overcast)

Bryophyte species	**Peloridiidae**
Breutelia dumosa	-
Breutelia subplicata	P. dar larva + larva[65]

[62] Unidentifiable
[63] Unidentifiable; kept in the same laboratory vial with specimens of *Peloridium pomponorum* from the same location, collected from *Sphagnum falcatulum*, thus is impossible to say, to which species the larvae belonged.
[64] Mostly unidentifiable.
[65] Unidentifiable.

Cladonia rangiferina[66]	-
Plagiochila stictaecola	-
Porella subsquarrosa	-
Ptychomnion cygnisetum	-
Sphagnum falcatulum[67]	3 adult P. pom + 10 larvae
Sphagnum fimbriatum[68]	3 adult P. pom + 10 larvae
Weymouthia mollis	-

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin, "S. Border"

S 41°53.135', W 73°40.183', elevation 44m. 30.01.2014 (strong rain in the morning, overcast in the afternoon)

Bryophyte species	**Peloridiidae**
Dicranoloma billarderii	-
Hypnum chrysogaster	1 adult P. pom
Ptychomnion densifolium	-
Racomitrium geronticum	-

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin, "Senda 1"

S 41°52.982', W 73°40.088', elevation 31m. 27.01.2014 (overcast first, later sunny)

Bryophyte species	**Peloridiidae**
aff. *Polytrichadelphus magellanus*	1 adult P. ham + 24 larvae

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin,"Makropter"

S 41°52.980', W 73°40.056', elevation 31m. 02.02.2014 (overcast to sunny); 07.02.2014 (sunny)

[66] A lichen; Drake & Salmon (1948, 1950) reported peloridiid occurrence on lichens in New Zealand.
[67] This *Sphagum* species was collected together with *S. fimbriatum*, so it is hard to say which of the species hosted Peloridiidae or if both of them did. Here, and later in similar cases, both bryophyte species are counted as host plants for calculation of specificity index.
[68] This *Sphagum* species was collected together with *S. falcatulum*, so it is hard to say which of the species hosted Peloridiidae or if both of them did. Here, and later in similar cases, both bryophyte species are counted as host plants for calculation of specificity index.

Bryophyte species	Peloridiidae
aff. *Polytrichadelphus magellanus*	42[69] adult P. ham + 39 larvae; 37 adult P. ham + 1 adult P. pom[70] + 11 larvae

Region X, Los Lagos, Isla grande de Chiloé, Ancud, Estacion biologica Senda Darwin,"Tepual 2"

S 41°52.746', W 73°40.611', elevation 20m. 28.01.2014 (sunny)

Bryophyte species	Peloridiidae
Bazzania peruviana	-
Dicranoloma billarderii	-
Sphagnum fimbriatum	12 adult P. pom + 15 larvae
Sphagnum magellanicum	13 adult P. pom + 7 larvae

Region X, Los Lagos, Isla grande de Chiloé, Parque Nacional de Chiloé, "Cucao Tepual 1"

S 42°37.085',W 74°06.150', elevation 11m. 03.02.2014 (overcast and quite windy, but not rainy), 07.02.2014 (sunny)

Bryophyte species	Peloridiidae
Arbusculohypopterygium arbuscula	4 adult P. dar + 6 larvae
Chiloscyphus horizontalis	2 larvae P. dar + 1 larva[71]
Hypnodendron microstictum	-
Plagiochila hookeriana[72]	1 adult P. dar + 1 adult P. hol + 1 larva P. hol
Plagiochila rubescens	1 adult P. dar + 1 adult P. hol + 1 larva P. hol
Ptychomniella ptychocarpa	-

[69] i.a. two macropterous specimens.

[70] At least one specimen of *P. magellanus* sample from the locality "Makropter" is identified as *P. pomponorum* with the key provided by Shcherbakov (2014). It has lighter colour of tegmina, smaller and lighter 2nd tarsal segment and shorter head areolae – all characters of that species according to Shcherbakov (2014). At the same time, the radial cell in the tegmen is apically more truncate than pointed (a character of *P. hammoniorum* according to Shcherbakov, 2014). Thus, this specimen cannot be identified with certainty using the disgnostic characters provided by Shcherbakov (2014).

[71] Unidentifiable.

[72] Both *Plagiochila* species at this locality were collected as a single sample (it was not recognized in the field that there are two species in the material), thus it is not certain if both *Plagiochila* were the host plants for Peloridiidae or only one of them.

Ptychomnion cygnisetum	-

A mix of bryophytes was analyzed from this locality on 07.02.2014 (the mix included i.a. *A. arbuscula* and *C. horizontalis*): 3 adult *P. darwini*, 3 larval *P. darwini* + 1 young unidentifiable larva.

Region X, Los Lagos, Isla grande de Chiloé, Parque Nacional de Chiloé, betw. Rancho Grande 1 and 2

(made on the track between the two points - Rancho Grande1: S 42°34.185', W 74°04.406', elevation 266m; Rancho Grande 2: S 42°33.549', W 74°04.451', elevation 449m). 05.02.2014 (sunny, only in the late afternoon some drops of rain)

Bryophyte species	**Peloridiidae**
Chiloscyphus horizontalis	-
Dendroligortichum dendroides	4 larvae[73]
Plagiochila hookeriana	-
Sphagnum capillifolium[74]	10 adult P. pom + 9 larvae
Sphagnum falcatulum	10 adult P. pom + 9 larvae
Sphagnum magellanicum	10 adult P. pom + 9 larvae

Region X, Los Lagos, Isla grande de Chiloé, Parque Nacional de Chiloé, "Lahuan"

S 42°37.279', W 74°06.324', elevation 21m. 03.02.2014 (overcast and quite windy, but not rainy)

Bryophyte species	**Peloridiidae**
Apometzgeria frontipilis	-
Arbusculohypopterygium arbuscula	-
Dicranoloma billarderii	1 larva[75]; -
Pseudocephalozia quadriloba	-, -
Ptychomnion cygnisetum	-
Rhaphidorrhynchium callidum	-
Riccardia prehensilis	-
Sphagnum falcatulum[76]	23 adult P. pom + 30 larvae

[73] Unidentifiable.
[74] This and the two following *Sphagnum* species were taken as one sample, thus it is hard to say if all three species hosted Peloridiidae or only some of them.
[75] Unidentifiable.

Sphagnum fimbriatum	23 adult P. pom + 30 larvae
Sphagnum magellanicum	5 adult P. pom
Thuidiopsis furfurosa	-, -

New Zealand

Stewart Island, Horseshoe Bay 1

S 46° 52,421', E 168° 07,304'; elevation 114 m. 13.02.2010 (sunny)

Bryophyte species	**Peloridiidae**
Bazzania adnexa	4 adult X. ste + 3 larvae[77]
Hypnodendron comatum	1 adult X. ste
Ptychomnion aciculare	-
Racopilum convolutaecum	1 larva X. ste
Schistochila sp.	1 adult X. ste + 2 larvae
*Schistochila glaucescens (*with *Ptychomnion aciculare)*	-

Stewart Island, Ulva 1

S 46° 55,729', E 168° 07,432'; elevation 46 m. 16.02.2010 (neither sunny nor rainy, but overcast and quite wet)

Bryophyte species	**Peloridiidae**
Bazzania adnexa	-
Bazzania novae-zelandiae	-
Hymenophyton leptopodum	10 adult X. ste + 6 larvae
Hypnodendron comatum	-

[76] This and the following *Sphagnum* species were taken as one sample, thus it is hard to say if both of them hosted Peloridiidae or only one.

[77] All larvae from localities on Stewart Island were counted as *Xenophysella stewartensis*, even if they could not be identified directly. They never demonstrated any morphological disparity, and the only other Peloridiidae from Stewart island, *Oiophysa paradoxa*, was only once found in a remote locality (Burckhardt, 2009) that was not sampled during this study.

Leucobryum candidum	-

Stewart Island, Ulva 3

S 46° 55,636', E 168° 07,539'; elevation 39 m. 17.02.2010 (a little sunnier than 16.02.10)

Bryophyte species	**Peloridiidae**
Dicranoloma billarderi	3 adult X. ste + 1 larva
Dicranoloma menziesii	3 adult X. ste + 1 larva
Dicranoloma plurisetum	1 adult X. ste + 2 larva
Plagiochila fasciculata	-

Stewart island, Horseshoe Bay 2

S 46° 52,335', E 168° 07,264'; elevation 56 m. 19.02.2010 (quite rainy)

Bryophyte species	**Peloridiidae**
Camptochaete arbuscula[78]	-
Hypopterygium rotulatum	1 adult X. ste + 1 larva
Leucobryum candidum	-
Weymouthia cochlearifolia[79]	-

South Island, Fiordland NP, Tutoko Valley

S 44° 40,283', E 167° 58,034'; elevation 137 m. 02.03.2010 (very rainy) and 04.03.2010 (overcast), on both days all plants are moist

[78] The absence of Peloridiidae in this sample could be attributed to stochastic factors like the sifted sample staying for too long in a plastic bag, too windy weather during the analysis in Berlese funnels which took place outside etc.

[79] The absence of Peloridiidae in this sample could be attributed to stochastic factors like the sifted sample staying for too long in a plastic bag, too windy weather during the analysis in Berlese funnels which took place outside etc.

Bryophyte species	Peloridiidae
Bazzania adnexa	4 adult X. rha + 5 larvae
Cryptopodium bartramioides	1 adult X. rha
Hymenophyton flabellatum	-
Hypnodendron menziesii	1 larva X. rha + 1 larva[80]
Leucobryum candidum	1 adult X. rha + 4 larvae
Schistochila appendiculata	4 adult X. rha + 1 larva
Tylimanthus saccatus	5 adult X. rha + 1 adult X. gre + 1 larva
Weymouthia cochlearifolia	-
Wijkia extenuata, hanging	-
Wijkia extenuata, normal	23 adult X. rha + 5 larvae

South Island, Fiordland NP, Key Summit

S 44° 48,906', E 168° 07,701'; elevation 912 m. 06.03.2010 (sunny)

Bryophyte species	Peloridiidae
Chandonanthus squarrosus	2 adult X. kin + 1 larva
Dicranoloma robustum	-
Racomitrium lanuginosum	-
Sphagnum cristatum	2 adult X. kin

South Island, Fiordland NP, Hollyford Valley

S 44° 44,417', E 168° 08,216'; elevation 102 m. 07.03.2010 (sunny)

Bryophyte species	Peloridiidae
Dendrohypopterygium filiculiforme	35 adult X. rha + 10 larvae
Papillaria leuconeura	-
Plagiochila stephensoniana	-
Weymouthia cochlearifolia	-

[80] Unidentifiable.

South Island, Fiordland NP, Key Summit track

S 44° 48,719', E 168° 07,816'; elevation 814 m. 08.03.2010 (very sunny)

Bryophyte species	Peloridiidae
Plagiochila circinalis	2 adult X. kin
Ptychomnion aciculare	1 adult X. kin + 2 larvae

South Island, Fiordland NP, Deadman's track 1

S 44° 45,138', E 168° 08,589'; elevation 177 m. 10.03.2010 (rainy) and 12.03.2010 (sunny)

Bryophyte species	Peloridiidae
Bazzania adnexa	2 adult X. rha
Dicranoloma dicarpum	3 adult X. rha + 2 larvae X. rha + 4 larvae
Plagiochila ramosissima	-
Wijkia extenuata	5 adult X. rha + 1 larva

South Island, Fiordland NP, Deadman's track 2

S 44° 45,183', E 168° 08,545'; elevation 174 m. 10.03.2010 (rainy) and 12.03.2010 (sunny)

Bryophyte species	Peloridiidae
Camptochaete ramulosa	+[81]
Dendrohypopterygium filiculiforme	1 adult O. dis + 10 adult X. rha + 2 larvae
Polytrichum juniperum	1 adult X. rha
Porella elegantula	1 adult X. rha + 1 larva

South Island, Westland Tai Poutini NP, Matheson 1

S 43° 26,550', E 169° 58,055'; elevation 124 m. 16.03.2010 (overcast, later rainy)

[81] The specimen must have been lost, since it is absent from the collection; the field notes only say that was an adult specimen, but do not mention the species. Although in this case it was most likely not an *Oiophysa*, since they are easily recognizable and rare and this would have been mentioned in the notes.

Bryophyte species	Peloridiidae
Dendrohypopterygium filiculiforme	11 adult O. dis + 3 larvae
Dendromastigophora flagellifera	-
Plagiochila gigantea	4 adult X. gre + 1 larva
Schistochila appendiculata[82]	3 adult X. gre

South Island, Kahurangi NP, Sylvester Lake's track

S 41° 06,690', E 172° 40,141'; elevation 799 m. 29.03.2010 and 01.04.2010 (more or less sunny on both days)

Bryophyte species	Peloridiidae
Canalohypopterygium tamariscinum	-
Climacium dendroides	-
Dendroligotrichum dendroides	-
Dicranoloma plurisetum	-
Dicranoloma robustum	2 adult O. abl + 3 larvae
Hypnodendron marginatum	-
Hypnum chrysogaster	-
Leucobryum candidum	5 adult O. abl
Plagiochila ramosissima	-
Ptychomnion aciculare	-
Pyrrhobryum mnioides	-
Weymouthia cochlearifolia	-
Wijkia extenuata	-

leaf litter, sifted – no Peloridiidae.

North Island, Rimutaka Forest Park, 5 miles track

S 41°20,417', E 174°58,305'; elevation 174 m. 06.04.2010 (overcast)

[82] Identification by photo only, but quite certain.

Bryophyte species	Peloridiidae
Dendrohypopterygium filiculiforme	-
Plagiochila stephensoniana	2 adult X. cas

North Island, Rimutaka Forest Park, Orongorongo 2

S 41°20,478', E 174° 57,439'; elevation 167 m. 06.04.2010 (overcast)

Bryophyte species	Peloridiidae
Dicranoloma billarderi	1 adult X. cas + 1 larva
Dicranoloma dicarpum	1 adult X. cas
Ptychomnion aciculare[83]	1 adult X. cas

North Island, Tararua Forest Park, Otaki forks

S 40° 52,172', E 175°13, 780'; elevation 152 m. 09, 11 and 12.04.2010 (all days sunny to overcast)

Bryophyte species	Peloridiidae
Calyptrochaeta cristata	1 adult X. cas
Canalohypopterygium tamariscinum	-
Catharomnion ciliatum	1 larva X. cas
Echinodium hispidum	3 adult X. cas + 2 larvae
Lopidium concinnum	2 adult X. cas + 2 larvae
Plagiochila stephensoniana	7 adult X. cas + 14 larvae
Ptychomnion aciculare	3 adult X. cas + 1 larva
Racopilum convolutaceum	1 larva X. cas
Wijkia extenuata	-

Leaf litter (12.04.2010), sifted – no pelos.

[83] Not exactly on the site "Orongorongo 2", more on the track some 200 meters before it, closer to the Rimutaka carpark.

North Island, Tongariro NP, Mangawhero Forest Walk 1

S 39° 23,896, E 175° 24,953'; elevation 566 m. 15.04.2010 (overcast)

Bryophyte species	**Peloridiidae**
Echinodium hispidum	1 adult O. cum
Leucobryum candidum	-
Lopidium concinnum	2 adult O. cum + 1 adult X. cas + 2 larvae
Plagiochila banksiana	-
Weymouthia cochlearifolia	-
Wijkia extenuata	-

North Island, Tongariro NP, Hauhungatahi

S 39° 13,690', E 175° 23,712'; elevation 262 m. 16.04.2010 (quite sunny)

Bryophyte species	**Peloridiidae**
Camptochaete arbuscula	2 adult O. cum + 2 larvae O. cum + 1 adult X. cas + 1 larva X. cas
Cryptopodium bartramioides[84]	-
Echinodium hispidum	2 adult X. cas + 3 larvae
Hypnodendron comatum	-
Leucobryum candidum	1 adult X. cas
Ptychomnion aciculare	3 adult X. cas + 1 larva

North Island, Tongariro NP, Mangawhero Forest Walk 2

S 39° 23,829', E 175° 25,031'; elevation 532 m. 17.04.2010 (overcast)

Bryophyte species	**Peloridiidae**
Dendrohypopterygium filiculiforme	1 adult X. cas + 1 larva
Hypnodendron comatum	-
Leucobryum candidum	-
Ptychomnion aciculare	-

[84] There are no notes or stored specimens concerning this species, but there are some indications that no peloridiids were gained from the moss.

10 Supplement 2. Occurrence of Peloridiidae species on different bryophytes and calculations of the specificity index

The following tables are based on the information contained in the Supplement 1., but are grouped according to the respective Peloridiidae species. The left column contains all the bryophyte species from all the localities where the peloridiid species was found. In the right column all the samples from the respective bryophyte species are given – as "-" when they did not deliver the respective Peloridiidae and as "+" when they did. As in the tables of the Supplement 1., different samples are divided by commas.

The selectivity index S is then calculated after the formula: S = (N – h)/N, where h is the number of the bryophyte species that delivered Peloridiidae at least once and N – the total number of bryophyte species.

Filmy fern or lichen samples that were collected on a few occasions and never contained Peloridiidae (s. Supplement 1.) are not considered in the calculations.

Hackeriella brachycephala

Bryophyte species	**Peloridiidae**
Atrichum androgynum	+
Breutelia pendula	-
Camptochaete arbuscula	+
Dicranoloma dicarpum	+, - , -, -
Dicranoloma sp.[85]	+, -, -, -
Lepidozia multifida	+
Lepidozia sp.[86]	+, -
Papillaria flavolimbata	+
Papillaria leuconeura	-
Plagiochila fasciculata	-
Thamnobryum pumilum	-
Wijkia extenuata	-, -, -

12 species, 7 of them hosts. S = 0,42

[85] There were four samples that could only be identified as *Dicranoloma* sp. – so, this line might stand for just a single species or up to 4 different ones.

[86] Similar as in the case of *Dicranoloma* above – there were two samples identified only as *Lepidozia* sp., so these two might be the same species or two different ones.

Hackeriella echina

Calculations for *H. echina* alone are impossible, since in the only sample where identifiable specimens of this species are present (Wanungara Lookout), there are also adult *H. veitchi* and unidentifiable larvae that could belong to either species.

Hackeriela veitchi

Bryophyte species	Peloridiidae
Bazzania cf. crassitexta	+
Cyathophorum bulbosum	-
Dawsonia superba	-, -
Dicranoloma dicarpum	+
Dicranoloma menziesii	+, -
Isopterygium albescens	-
Lepidozia sp.	-
Papillaria crocea	-, -
Papillaria flavolimbata	-
Papillaria leuconeura	-
Plagiochila baileyana	-
Plicanthus hirtellus	+
Ptychomnion aciculare	+
Rosulabryum billarderi	-
Wijkia extenuata	-

15 species, 5 of them hosts. S = 0,67

Hackeriella echina + Hackeriella veitchi

Bryophyte species	Peloridiidae
Bazzania adnexa	+
Bazzania cf. crassitexta	+
Bazzania fasciculata	-
Calliergonella cuspidata	-
Camptochaete arbuscula	-
Cyathophorum bulbosum	-, -
Dawsonia superba	-, -
Dicranoloma dicarpum	+, +, -
Dicranoloma menziesii	+, +, +, -, -

Dicranoloma robustum	-, -
Echinodium hispidum	-
Isopterygium albescens	-
Lepidozia multifida	-
Lepidozia ulothrix	+
Lepidozia sp.	-
Papillaria crocea	-, -
Papillaria flavolimbata	-
Papillaria leuconeura	-, -
Papillaria sp.	-
Plagiochila baileyana	-
Plicanthus hirtellus	+, -
Ptychomnion aciculare	+
Pyrrhobryum parramattense	+, -, -
Rosulabryum billarderi	-
Thuidiopsis sparsa	-
Trachyloma planifolium	-
Weymouthia cochlearifolia	-
Wijkia extenuata	+, +, -

28 species, 9 of them hosts. S = 0,68

Hemiodoecellus fidelis

Bryophyte species	**Peloridiidae**
Hypnodendron vitense	H. lea
Leucobryum candidum	H. fid + larvae[87]
Ptychomnion aciculare	-
Wijkia extenuata	-

4 species, 1 of them hosts. S = 0,75

[87] Only three are 5th instars that can be identified (*H. fidelis*), the rest is too young.

Hemiodoecus acutus

As this species often occurred on the same host plants as *H. wilsoni*, the bryophyte samples that only contained larvae are not considered in calculations of the host plant specificity, since larvae could not be identified with certainty. All minuses from Supplement 1 are considered, and cases where only adult *H. wilsoni* were obtained from a bryophyte sample are counted as minuses.

Bryophyte species	**Peloridiidae**
Adelanthus bisetulus	-
Balantiopsis diplophyllum	larva
Bazzania adnexa	-, -, -
Camptochaete deflexa	larvae
Camptochaete sp.	-
Dicranoloma menziesii	-, -, -
Fissidens oblongifolius	-
Hymenophyton flabellatum	H. acu.
Hypnodendron spininervium	-
Hypnum chrysogaster	-
Kindbergia praelonga	H. acu + larvae
Lepidozia septemfida	-
Lepidozia sp.	-
Leucobryum candidum	H. wil.; larva; -
Lopidium concinnum	larvae; -
Papillaria flavolimbata	-
Plagiochila strombifolia	-
Podomitrium phillanthus	-
Ptychomnion aciculare	H. wil. + larva; -
Rhizogonium distichum	larva
Rosulabryum billarderi	-
Rosulabryum subtomentosum	H. acu. + H. wil.
Schistochila lehmanniana	H. acu. + H. wil. + larvae; H. acu
Symphyogyna podophylla	-
Trichocolea mollissima	-, -
Tylimanthus tenellus	-
Weymouthia mollis	-
Wijkia extenuata	H. wil.; H. acu; H. acu + H. wil. + larvae; -

25 species, 5 of them hosts. S = 0, 8

Hemiodoecus crassus

Bryophyte species	Peloridiidae
Rosulabryum torquescens	-
Sphagnum cristatum	H. cra. + larvae

2 species, one of them host. S = 0,5

Hemiodoecus leai

NSW, Kosciuszko NP

Bryophyte species	Peloridiidae
Aulacomnium palustre	-
Breutelia pendula	-
Sphagnum cristatum	H. leai + larvae
Sphagnum sp.	H. leai +larvae; larva; -

4 species, two of them hosts. S = 0,5

VIC, Yarra Ranges NP

Bryophyte species	Peloridiidae
Achrophyllum dentatum	-
Atrichum androgynum	-
Balantiopsis diplophyllum	-
Bazzania adnexa	larva; -; -
Camptochaete sp.	-
Dicranoloma menziesii	-, -
Hypnodendron sp.	-
Lepidozia sp.	-
Plagiochila strombifolia	-
Ptychomnion aciculare	-
Wijkia extenuata	larva; -; -

12 species, two of them hosts. S = 0, 83

Tasmania

Since *H. leai* occurs in the sampled localities together with *H. fidelis* (Burckhardt, 2009), the samples where younger larvae were present were not considered in calculations of the specificity index.

Bryophyte species	**Peloridiidae**
Bartramia compacta	larva[88]
Bazzania adnexa	H. leai
Catagonium nitens	-
Chiloscyphus limosus	H. leai + larvae[89]
Dicranoloma robustum	-
Lepidozia multifida	-
Ptychomnion aciculare	H. leai
Wijkia extenuata	-
Hypnodendron vitense	H. leai
Leucobryum candidum	H. fidelis + larvae[90]
Ptychomnion aciculare	-
Wijkia extenuata	-

10 species, 4 of them hosts. S = 0,6

All regions together

Bryophyte species	**Peloridiidae**
Achrophyllum dentatum	-
Atrichum androgynum	-
Aulacomnium palustre	-
Balantiopsis diplophyllum	-
Bazzania adnexa	+, +, -, -
Breutelia pendula	-
Camptochaete sp.	-
Catagonium nitens	-
Chiloscyphus limosus	+
Dicranoloma menziesii	-, -
Dicranoloma robustum	-
Hypnodendron vitense	+
Hypnodendron sp.	-
Lepidozia multifida	-
Lepidozia sp.	-

[88] Too young, unidentifiable.
[89] One 5th instar larva (*H. leai*), others too young and unidentifiable.
[90] Three 5th instar larvae (*H. fidelis*), the rest too young and unidentifiable.

Plagiochila strombifolia	-
Ptychomnion aciculare	+, -, -
Sphagnum cristatum	+
Sphagnum sp.	+, +, -
Wijkia extenuata	+, -, -, -, -

20 species, 7 of them hosts. S = 0,65

Hemiowoodwardia wilsoni

Since this species often occurred on the same host plants as *H. acutus*, the bryophyte samples that only contained larvae are not considered in calculations of the host plant specificity (younger larvae cannot not be identified with certainty). All minuses from Supplement 1 are counted, and cases where only adult *H. acutus* were obtained from a bryophyte sample are counted as minuses.

Bryophyte species	**Peloridiidae**
Adelanthus bisetulus	-
Balantiopsis diplophyllum	larva
Bazzania adnexa	-, -, -
Camptochaete deflexa	larvae
Camptochaete sp.	-
Dicranoloma menziesii	-, -, -
Fissidens oblongifolius	-
Hymenophyton flabellatum	H. acu.
Hypnodendron spininervium	-
Hypnum chrysogaster	-
Kindbergia praelonga	H. acu + larvae
Lepidozia septemfida	-
Lepidozia sp.	-
Leucobryum candidum	H. wil.; larva; -
Lopidium concinnum	larvae; -
Papillaria flavolimbata	-
Plagiochila strombifolia	-
Podomitrium phillanthus	-
Ptychomnion aciculare	H. wil. + larva; -
Rhizogonium distichum	larva
Rosulabryum billarderi	-
Rosulabryum subtomentosum	H. acu. + H. wil.
Schistochila lehmanniana	H. acu. + H. wil. + larvae; H. acu
Symphyogyna podophylla	-
Trichocolea mollissima	-, -

Tylimanthus tenellus	-
Weymouthia mollis	-
Wijkia extenuata	H. wil.; H. acu; H. acu + H. wil. + larvae; -

23 species, 5 of them hosts. S = 0,78

Hemiodoecus acutus + Hemiowoodwardia wilsoni

Bryophyte species	**Peloridiidae**
Adelanthus bisetulus	-
Balantiopsis diplophyllum	larva
Bazzania adnexa	-, -, -
Camptochaete deflexa	larvae
Camptochaete sp.	-
Dicranoloma menziesii	-, -, -
Fissidens oblongifolius	-
Hymenophyton flabellatum	H. acu.
Hypnodendron spininervium	-
Hypnum chrysogaster	-
Kindbergia praelonga	H. acu + larvae
Lepidozia septemfida	-
Lepidozia sp.	-
Leucobryum candidum	H. wil.; larva; -
Lopidium concinnum	larvae; -
Papillaria flavolimbata	-
Plagiochila strombifolia	-
Podomitrium phillanthus	-
Ptychomnion aciculare	H. wil. + larva; -
Rhizogonium distichum	larva
Rosulabryum billarderi	-
Rosulabryum subtomentosum	H. acu. + H. wil.
Schistochila lehmanniana	H. acu. + H. wil. + larvae; H. acu
Symphyogyna podophylla	-
Trichocolea mollissima	-, -
Tylimanthus tenellus	-
Weymouthia mollis	-
Wijkia extenuata	H. wil.; H. acu; H. acu + H. wil. + larvae; -

28 species, 11 of them hosts. S = 0,61

Idophysa chonos

An adult of this species was obtained from one mixed sample of bryophytes: *Balantiopsis cancellata, Kurzia setiformis, Bazzania peruviana, Plagiochila lophocoleoides*; taken on 05.02.104 at a spot on Rancho Grande track without documented coordinates (close to the iron bridge).

A larva (5th instar) of the species was obtained form *Dendroligotrichum dendroides* not far from the same spot on Rancho Grande track.

Oiophysa ablusa

Bryophyte species	**Peloridiidae**
Canalohypopterygium tamariscinum	-
Climacium dendroides	-
Dendroligotrichum dendroides	-
Dicranoloma plurisetum	-
Dicranoloma robustum	+
Hypnodendron marginatum	-
Hypnum chrysogaster	-
Leucobryum candidum	+
Plagiochila ramosissima	-
Ptychomnion aciculare	-
Pyrrhobryum mnioides	-
Weymouthia cochlearifolia	-
Wijkia extenuata	-

13 species, 2 of them hosts. S = 0,85

Oiophysa cumberi

Bryophyte species	**Peloridiidae**
Camptochaete arbuscula	+
Cryptopodium bartramioides	-
Echinodium hispidum	-[91], +
Hypnodendron comatum	-
Leucobryum candidum	-, -
Lopidium concinnum	+
Plagiochila banksiana	-
Ptychomnion aciculare	+[92]

[91] This could be a "+", due to an unclear passage in the field notes. There is one *O.cumberi* larva in the catches, whose origin is not obvious from the notes – it either came from *P. aciculare* or from *E. hispidum*.

Weymouthia cochlearifolia	-
Wijkia extenuata	-

10 species, 3 or 4 of them hosts. S = 0,6

Oiophysa distincta

Bryophyte species	**Peloridiidae occurence**
Camptochaete ramulosa	-
Dendrohypopterygium filiculiforme	+, +
Dendromastigophora flagellifera	-
Plagiochila gigantea	-
Polytrichum juniperum	-
Porella elegantula	-
Schistochila appendiculata[93]	-

7 species, 1 of them host. S = 0,86

Pantinia darwini

Bryophyte species	**Peloridiidae**
Arbusculohypopterygium arbuscula	P. dar.
Breutelia dumosa	-
Breutelia subplicata	P. dar. larva + undet. larva
Chiloscyphus horizontalis	P. dar.
Hypnodendron microstictum	-
Plagiochila hookeriana[94]	P. dar. + P. hol.
Plagiochila rubescens	P. dar. + P. hol.
Plagiochila stictaecola	-
Porella subsquarrosa	-
Ptychomniella ptychocarpa	-
Ptychomnion cygnisetum	-, -
Sphagnum falcatulum[95]	P. pom.

[92] This could be a "-", due to an unclear passage in the field notes. There is one *O.cumberi* larva in the catches, whose origin is not obvious from the notes – it either came from *P. aciculare* or from *E. hispidum*.
[93] Identification based on photos and field experience.
[94] Both *Plagiochila* species at this locality were collected as a single sample (it was not recognized in the field that there are two species in the sample), thus it is not certain if both *Plagiochila* can be host plants for Peloridiidae or only one of them.
[95] Was collected together with *S. fimbriatum*, so it is hard to say, which of the species hosted Peloridiidae, or if it were both of them

Sphagnum fimbriatum[96]	P. pom.
Weymouthia mollis	-

14 species, 5 of them hosts. S = 0,64

Specimens of *P. darwini* were also obtained from mixed bryophyte samples in the locality "Cucao Tepual 2" (S 42°37.080', W 74°06.088', elevation 16m; at most a hundred meters away from "Cucao Tepual 1")

Peloridium hammoniorum

Bryophyte species	**Peloridiidae**
Arbusculohypopterygium arbuscula	-
Dicranoloma billarderii	-, -
Dicranoloma robustum	-
aff. *Polytrichadelphus magellanus*	+, +, +, +, +
Plagiochila lophocoleoides	-
Plagiochila stictaecola	-
Ptychomnion cygnisetum	-
Sphagnum falcatulum	+

8 species, 2 of them hosts. S = 0,75

Peloridium pomponorum

Cases where only young unidentifiable larvae were found are not considered when calculating the specificity index S.

Bryophyte species	**Peloridiidae**
Apometzgeria frontipilis	-
Arbusculohypopterygium arbuscula	-, -
Bazzania peruviana	-
Breutelia dumosa	-
Breutelia subplicata	-
Chiloscyphus horizontalis	-
Dendroligortichum dendroides	larvae[97]
Dicranoloma billarderii	larvae[98]; -, -, -, -, -

[96] Was collected together with *S. falcatulum*, so it is hard to say, which of the species hosted Peloridiidae, or if it were both of them.
[97] Too young, unidentifiable.
[98] Too young, unidentifiable.

Dicranoloma robustum	-
Hypnum chrysogaster	+
aff. *Polytrichadelphus magellanus*	+[99], -
Plagiochila hookeriana	-
Plagiochila lophocoleoides	-
Plagiochila stictaecola	-, -
Porella subsquarrosa	-
Pseudocephalozia quadriloba	-, -
Ptychomnion cygnisetum	-, -, -
Ptychomnion densifolium	-
Rhaphidorrhynchium callidum	-
Riccardia prehensilis	-
Sphagnum capillifolium[100]	+
Sphagnum falcatulum	+, +, +, +, +, +
Sphagnum fimbriatum	+, +, +
Sphagnum magellanicum	+, +, +
Thuidiopsis furfurosa	-, -
Weymouthia mollis	-

26 species, 6 of them hosts. S = 0,77

Peloridora holdgatei

Bryophyte species	**Peloridiidae**
Arbusculohypopterygium arbuscula	P. dar.
Chiloscyphus horizontalis	P. dar.
Hypnodendron microstictum	-
Plagiochila hookeriana[101]	P. dar. + P. hol.
Plagiochila rubescens	P. dar. + P. hol.
Ptychomniella ptychocarpa	-
Ptychomnion cygnisetum	-

[99] At least one specimen from *Polytrichadelphus magellanus* sample from the locality "Makropter" was identified as *P. pomponorum* with the key provided by Shcherbakov (2014). It has lighter colour of tegmina, smaller and lighter second tarsal segment and shorter head areolae – all characters of that species according to Shcherbakov (2014). At the same time, the radial cell in the tegmen is apically more truncate than pointed (a character of *P. hammoniorum* according to Shcherbakov, 2014). Thus, this specimen cannot be identified with certainty using the disgnostic characters provided by Shcherbakov (2014).

[100] This *Sphagnum* species was taken in a mixed sample together with *S. falcatulum* and *S. magellanicum* about which it is known that they can act as host plants – whether *S. capillifolium* can, is uncertain, since it was not tested alone.

[101] Both *Plagiochila* species at this locality were collected as a single sample (it was not recognized in the field that there are two species in the sample), thus it is not certain if both *Plagiochila* can be host plants for Peloridiidae or only one of them.

7 species, 2 of them hosts. S = 0,71

Specimens of *P. holdgatei* were also obtained from mixed bryophyte samples:

- *Campylopus acuminatus, Dicranoloma billardieri, Dicranoloma imponens, Herbertus runcinatus, Jamesoniella colorada, Lepicolea ochroleuca*, 05.02.2014, Rancho Grande 2 (S 42°33.549', W 74°04.451', elevation 449m)
- *Acromastigum anisostomum, Dicranoloma billardieri, Lepicolea ochroleuca, Riccardia prehensilis*, 05.02.2014, Rancho Grande 1 (S 42°34.185', W 74°04.406', elevation 266m)
- *Balantiopsis cancellata, Kurzia setiformis, Bazzania peruviana, Plagiochila lophocoleoides* – on 05.02.2014, from a place on Rancho Grande track with unknown coordinates

Xenophyes cascus

Bryophyte species	**Peloridiidae**
Calyptrochaeta cristata	+
Camptochaete arbuscula	+
Canalohypopterygium tamariscinum	-
Catharomnion ciliatum	+
Cryptopodium bartramioides	-
Dendrohypopterygium filiculiforme	+, +, -
Dicranoloma billarderi	+
Dicranoloma dicarpum	+
Echinodium hispidum	+, +, -
Hypnodendron comatum	-, -
Leucobryum candidum	+, -, -
Lopidium concinnum	+, +
Plagiochila banksiana	-
Plagiochila stephensoniana	+, +
Ptychomnion aciculare	+, +, +, -
Racopilum convolutaceum	+, +
Weymouthia cochlearifolia	-
Wijkia extenuata	-, -

18 species, 12 of them hosts. S = 0,33

Xenophyes kinlochensis

Bryophyte species	Peloridiidae
Chandonanthus squarrosus	+
Dicranoloma robustum	-
Plagiochila circinalis	+
Ptychomnion aciculare	+
Racomitrium lanuginosum	-
Sphagnum cristatum	+

6 species, 4 of them hosts. S = 0,33

Xenophyes rhachilophus

Bryophyte species	Peloridiidae
Bazzania adnexa	+, +
Camptochaete ramulosa[102]	+
Cryptopodium bartramioides	+
Dendrohypopterygium filiculiforme	+, +
Dicranoloma dicarpum	+
Hymenophyton flabellatum	-
Hypnodendron menziesii[56]	+
Leucobryum candidum	+
Papillaria leuconeura	-
Plagiochila ramosissima	-
Plagiochila stephensoniana	-
Polytrichum juniperum	+
Porella elegantula	+
Schistochila appendiculata	+
Tylimanthus saccatus	+
Weymouthia cochlearifolia	-, -
Wijkia extenuata, pendant life form	-
Wijkia extenuata, mat life form	+, +

18[103] species, 12 of them hosts (10, if *C. ramulosa* and *H. menziesii* are omitted). S = 0,38

[102] The species *H. menziesii* and *C. ramulosa* are not counted here, although they delivered Peloridiidae, since in the case of *H. menziesii* those were unidentifiable larvae and in the case of *C. ramulosa* the specimen was lost (it was noted in the records, but not identified at the time).

[103] Pendant life form of *Wijkia extenuata* reckoned here a different „species“, since it was found out in the course of the study that Peloridiidae can live and feed on a bryophyte species on the ground, but avoid it when it is growing pending from a tree, therefore this life form had to be separarted in an own category.

Xenophysella greensladeae

Bryophyte species	Peloridiidae
Bazzania adnexa	-
Cryptopodium bartramioides	-
Dendrohypopterygium filiculiforme	-
Dendromastigophora flagellifera	-
Hymenophyton flabellatum	-
Hypnodendron menziesii	-
Leucobryum candidum	-
Plagiochila gigantea	+
Schistochila appendiculata[104]	+, -
Tylimanthus saccatus	+
Weymouthia cochlearifolia	-
Wijkia extenuata, pendant life form	-
Wijkia extenuata, mat life form	-

13[105] species, 3 of them hosts. S = 0,77

Xenophysella stewartensis

Bryophyte species	Peloridiidae
Bazzania adnexa	+, -
Bazzania novae-zelandiae	-
Camptochaete arbuscula[106]	-
Dicranoloma billarderi	+
Dicranoloma menziesii	+
Dicranoloma plurisetum	+
Hymenophyton leptopodum	+
Hypnodendron comatum	+, -
Hypopterygium rotulatum	+
Leucobryum candidum	-, -
Plagiochila fasciculata	-
Ptychomnion aciculare	-
Racopilum convolutaceum	+

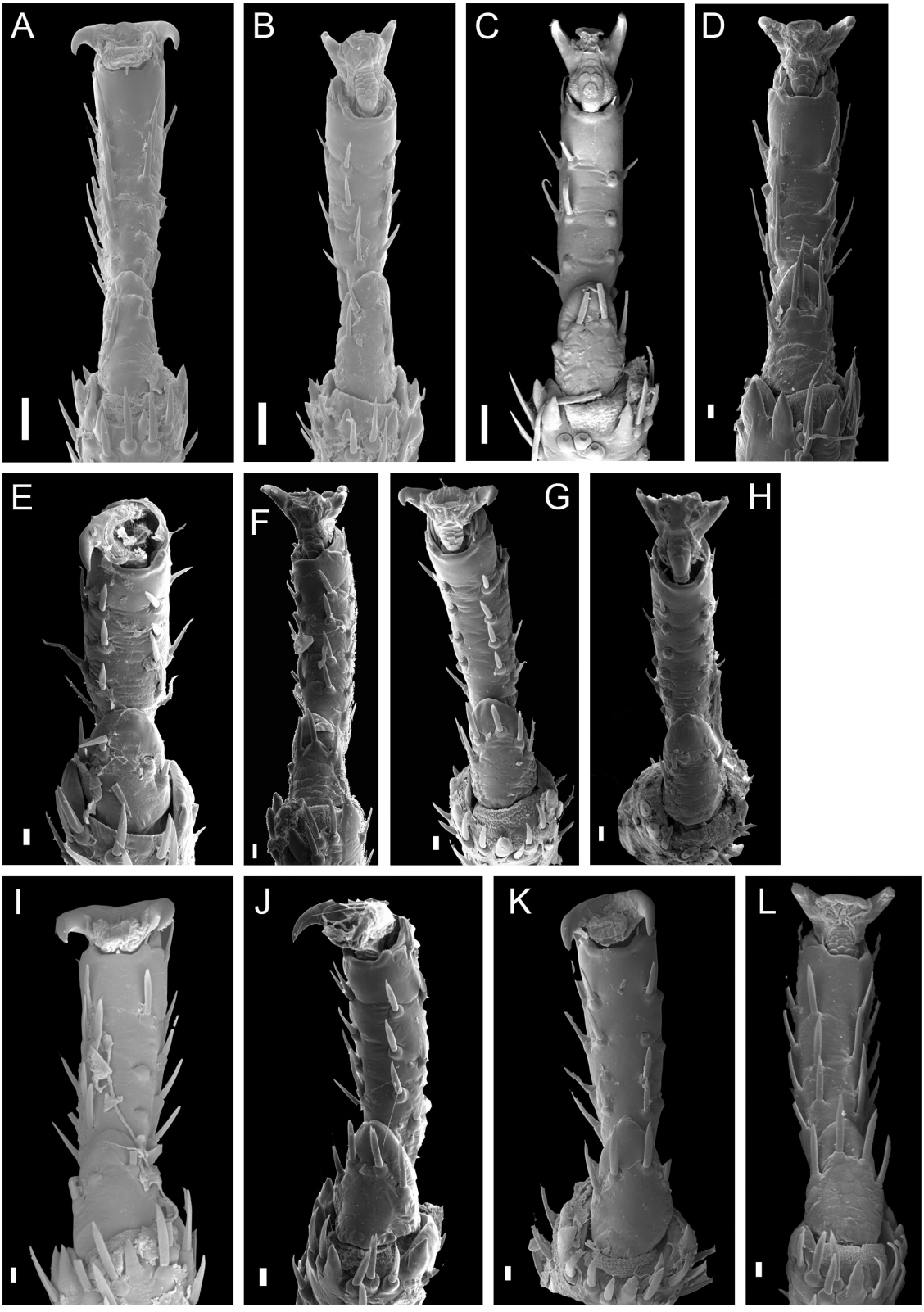
[104] In one case identification by photos and field experience.
[105] Pendant life form of *Wijkia extenuata* reckoned here a different „species“, since it was found out in the course of the study that Peloridiidae can live and feed on a bryophyte species on the ground, but avoid it when it is growing pending from a tree, therefore this life form had to be separarted in an own category.
[106] The absence of Peloridiidae in this sample could be attributed to stochastic factors like the sifted sample staying for too long in a plastic bag, too windy weather during the analysis in Berlese funnels which took place outside etc.

Schistochila sp.	+
Schistochila glaucescens (with *Ptychomnion aciculare*)	-
Weymouthia cochlearifolia[60]	-

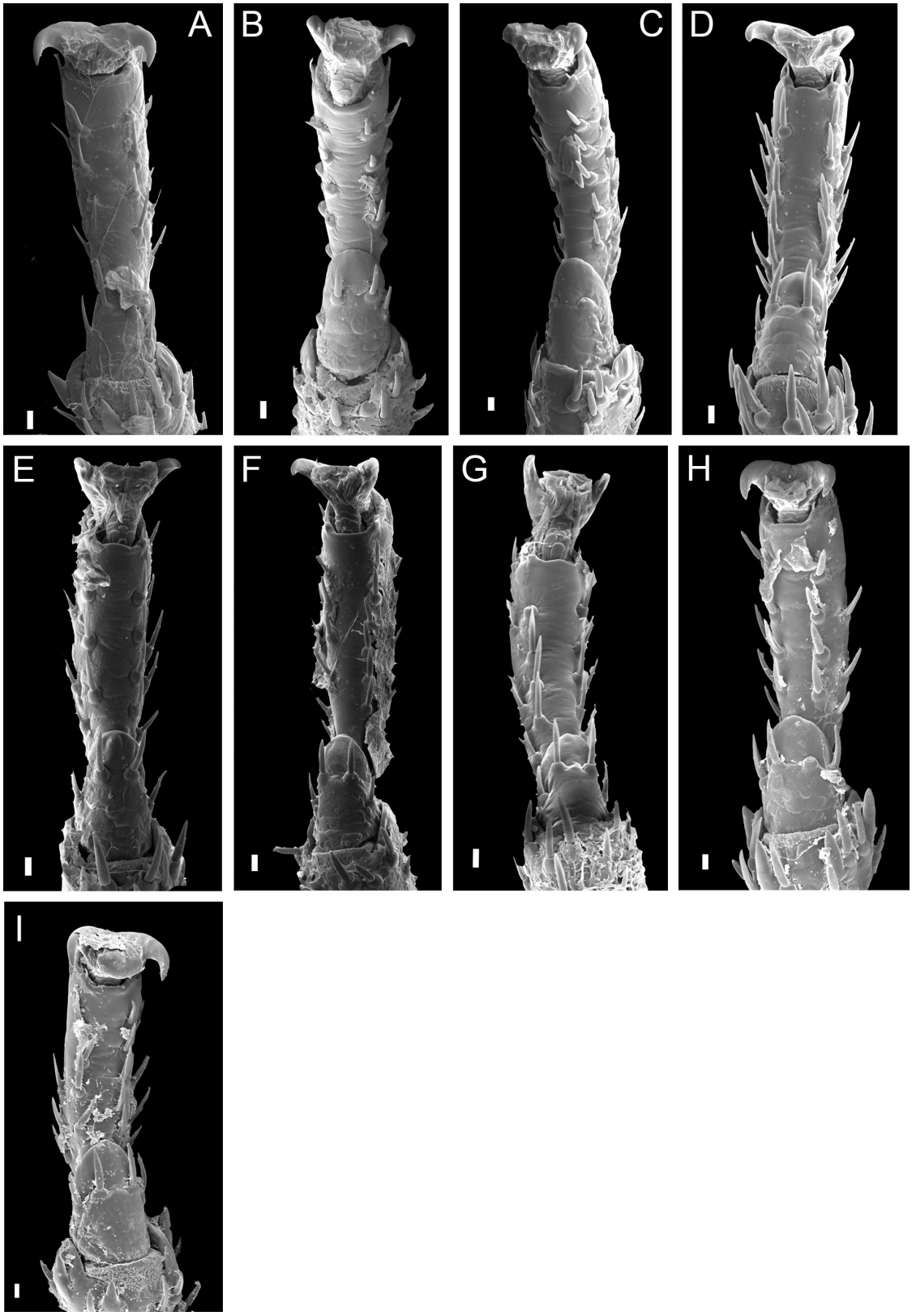
16 species, 9 of them hosts. S = 0,44

11 Supplement 3. Illustrations of relevant morphological traits in the studied species of Peloridiidae

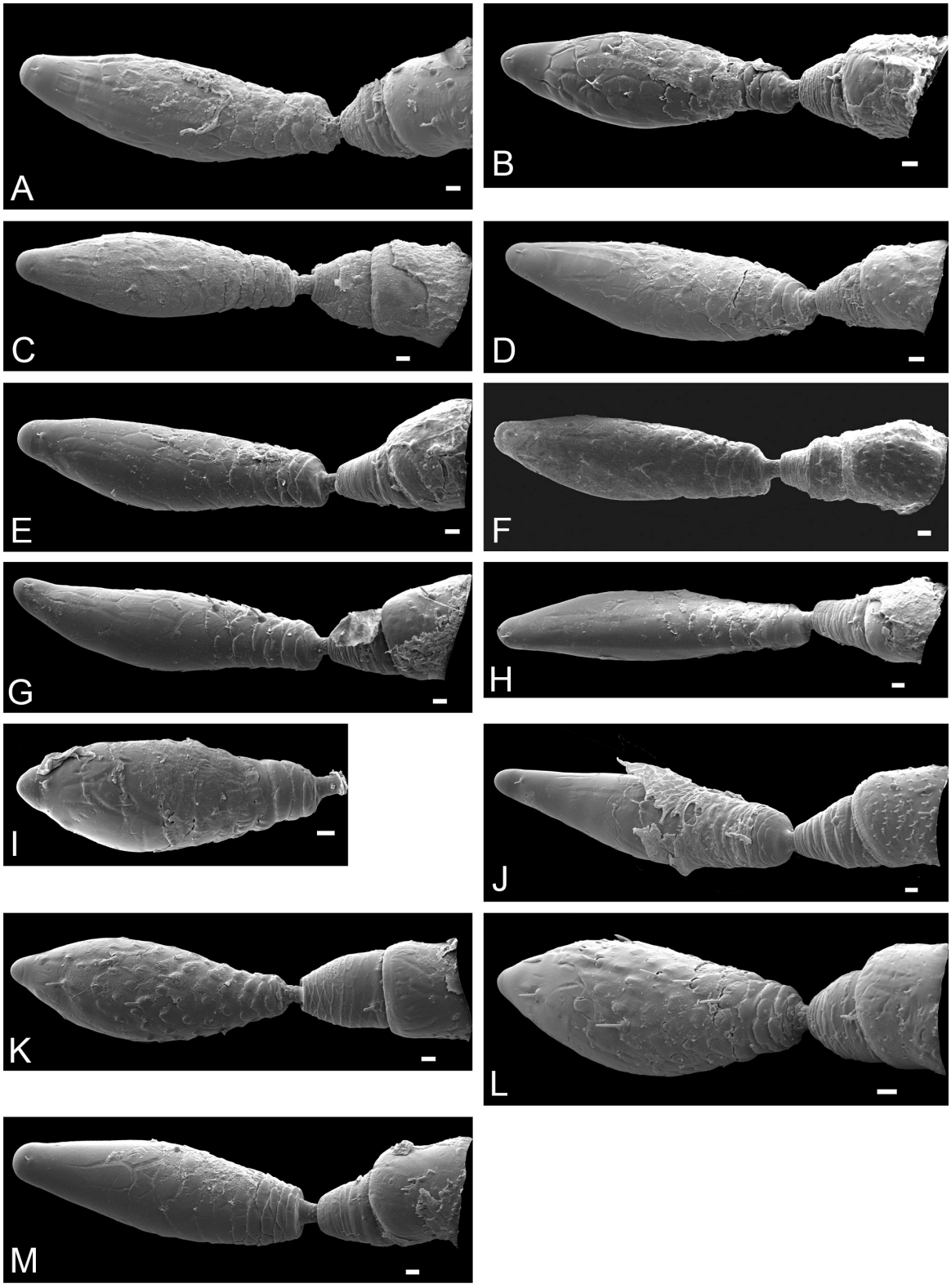
Illustrations of the character complexes used in the present study (tarsi and distal tibiae, antennae, genae, abdominal tergal sculpture, tegminal sculpture, labial sensilla, integumental glands) are presented for Peloridiidae species analyzed. These illustrations should make the decisions behind the coding of the character states in the matrix (Results, section 3.4.) more obvious and easier to follow and can provide additional clues.



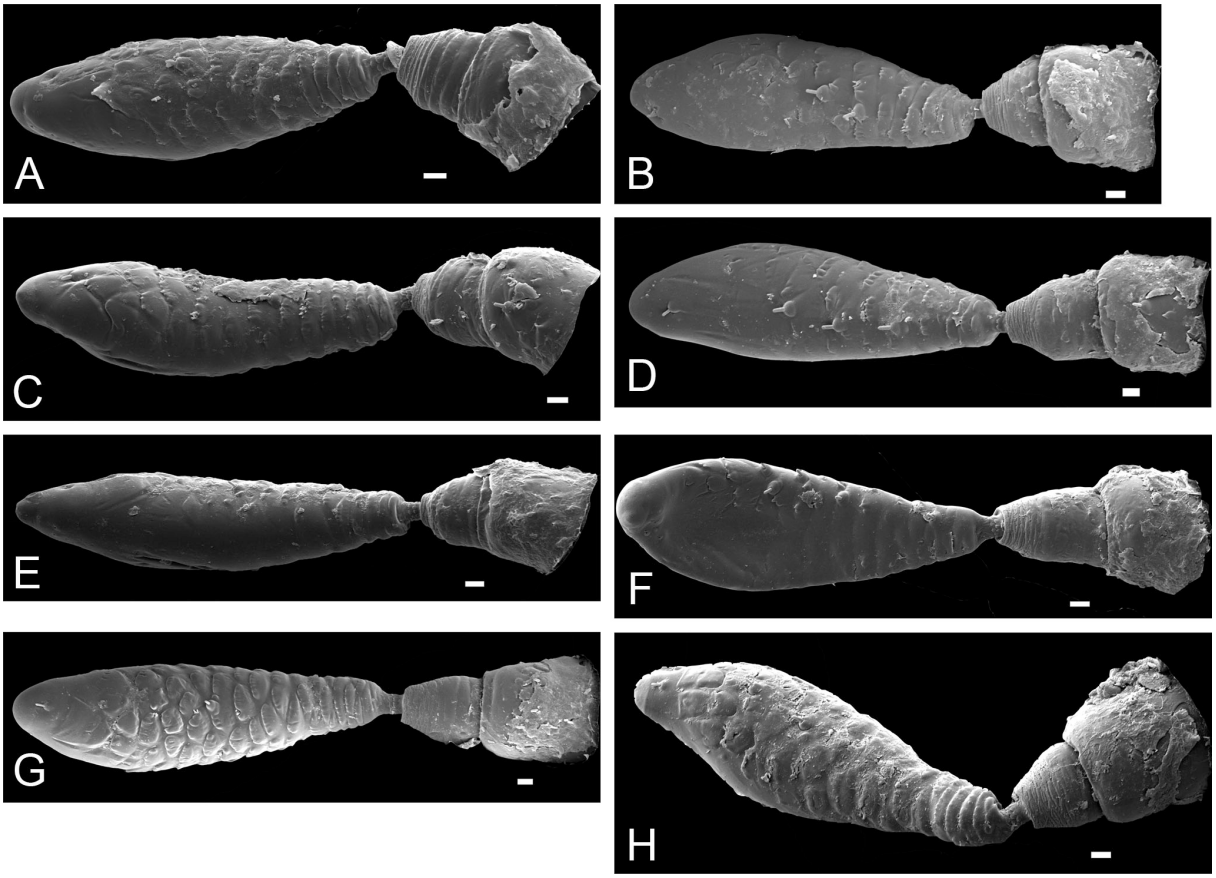
Supplement 3. Fig. 1: Tarsi in Peloridiidae. A – *Peloridium hammoniorum*, B – *Peloridium pomponorum*, C – *Peloridora holdgatei*, D – *Pantinia darwini*, E – *Idophysa chonos,* F – *Hackeriella brachycephala*, G – *Hackeriella echina*, H – *Hackeriella veitchi*, I – *Hemiodoecus acutus*, J – *Hemiodoecus crassus*, K – *Hemiodoecus leai*, L – *Hemiowoodwardia wilsoni*. Scale bars: A – 30 µm; B, C – 20 µm; others – 10 µm.



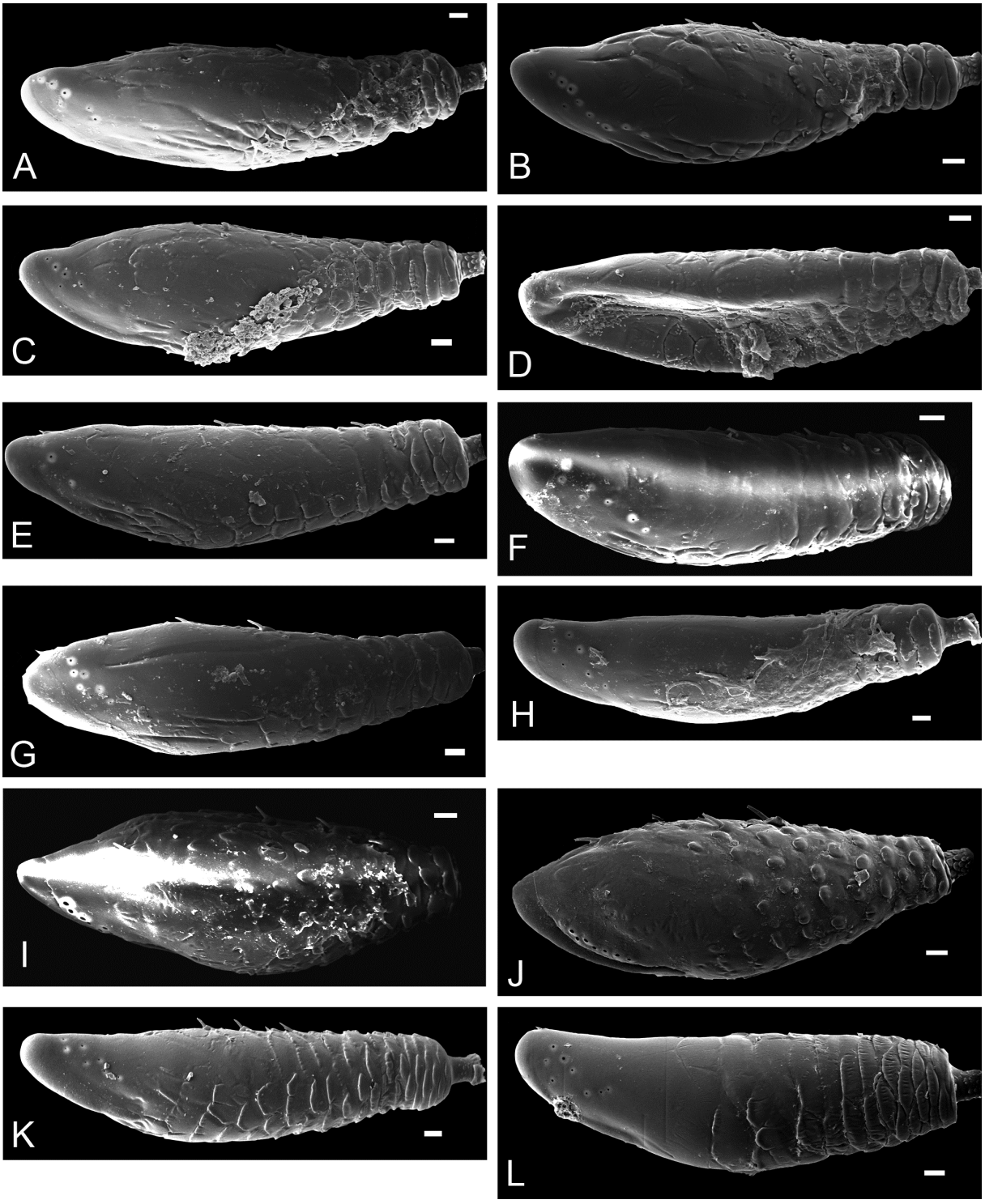
Supplement 3. Fig 2: Tarsi in Peloridiidae. A – *Hemiodoecellus fidelis*, B – *Xenophyes cascus*, C – *Xenophyes kinlochensis*, D – *Xenophyes rhachilophus*, E – *Oiophysa ablusa*, F – *Oiophsya cumberi* – G – *Oiophysa distincta*, H – *Xenophysella greensladeae*, I – *Xenophysella stewartensis*. Scale bars: 10 µm.



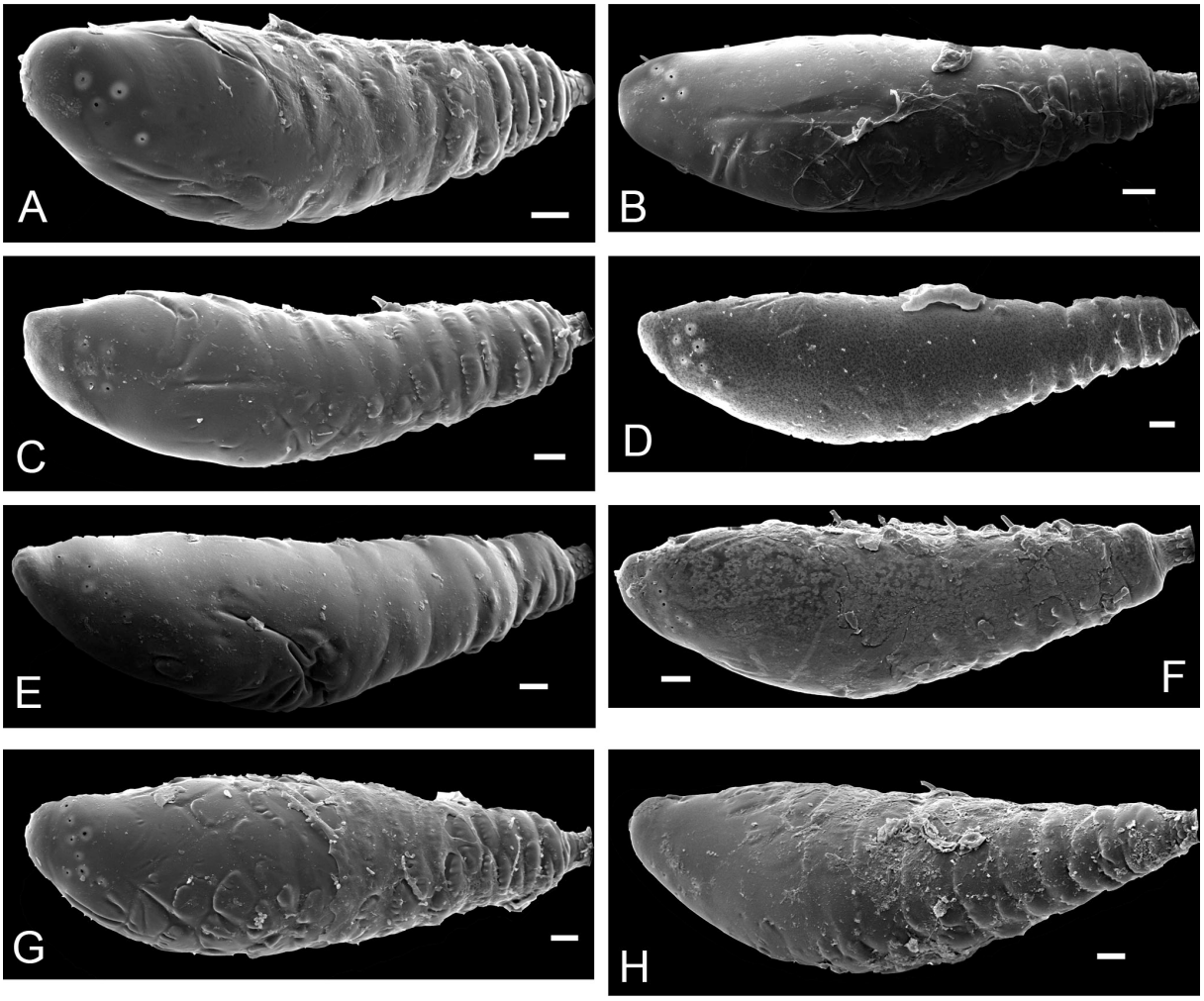
Supplement 3. Fig 3: Antennae in Peloridiidae, ventral view. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecellus fidelis*, E – *Hemiodoecus acutus*, F – *Hemiodoecus crassus*, G – *Hemiodoecus leai*, H – *Hemiowoodwardia wilsoni*, I – *Idophysa chonos*, J – *Pantinia darwini*, K – *Peloridium hammoniorum*, L – *Peloridium pomponorum*, M – *Peloridora holgatei*. Scale bars: 10 µm.



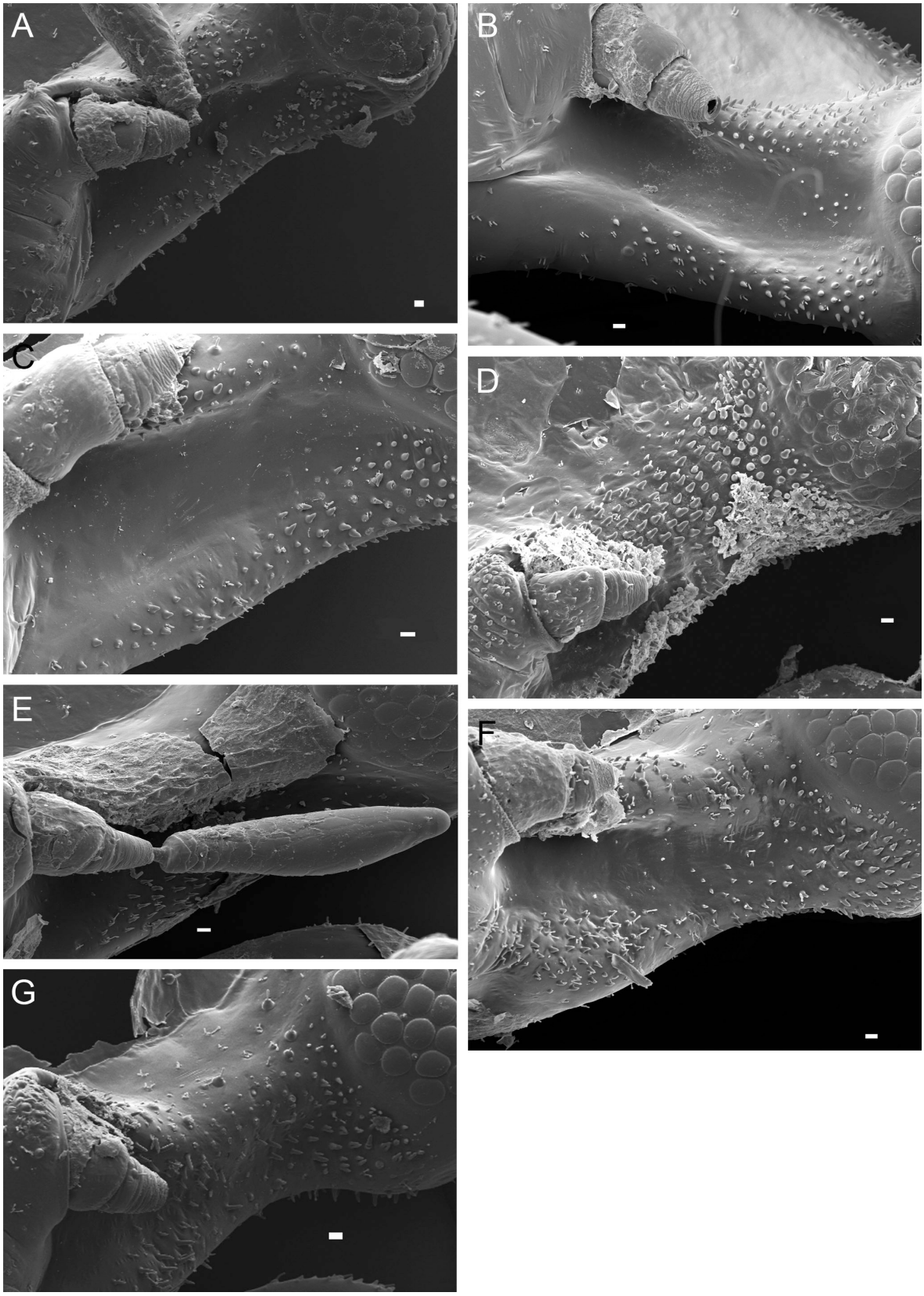
Supplement 3. Fig 4: Antennae in Peloridiidae, ventral view. A – *Oiophysa ablusa*, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophyes cascus*, E – *Xenophyes kinlochensis*, F – *Xenophyes rhachilophus*, G – *Xenophysella greensladeae*, H – *Xenophysella stewartensis*. Scale bars: 10 µm.



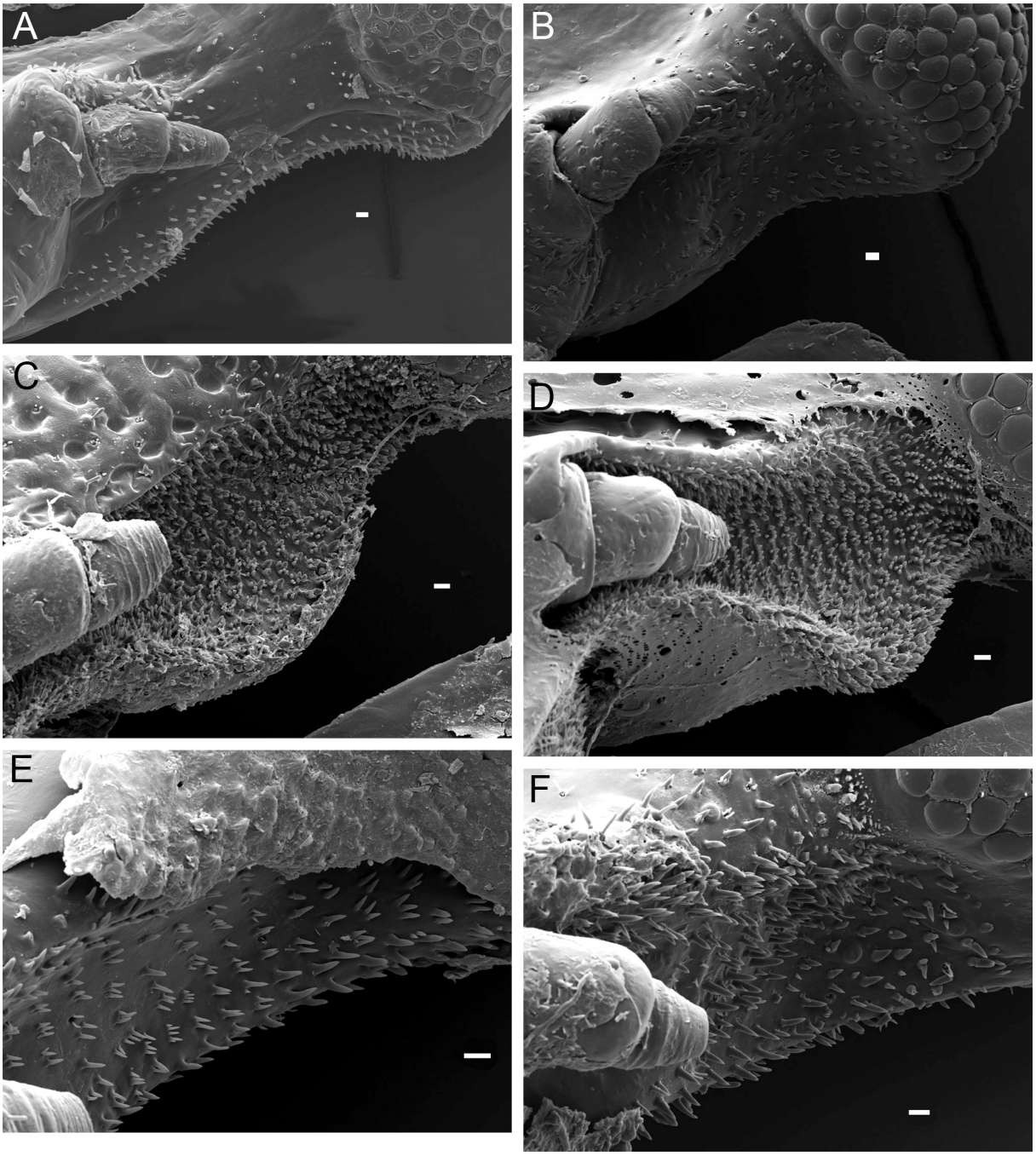
Supplement 3. Fig. 5: Antennae in Peloridiidae, caudal view (viewer's facing the posterior surface of the flagellum, the ventral side is above and the dorsal below). A - *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecellus fidelis*, E – *Hemiodoecus acutus*, F – *Hemiodoecus crassus*, G – *Hemiodoecus leai*, H – *Hemiowoodwardia wilsoni*, I – *Peloridium pomponorum*, J – *Peloridium hammoniorum,* K – *Pantinia darwini*, L – *Peloridora holgatei*. Scale bars: 10 μm.



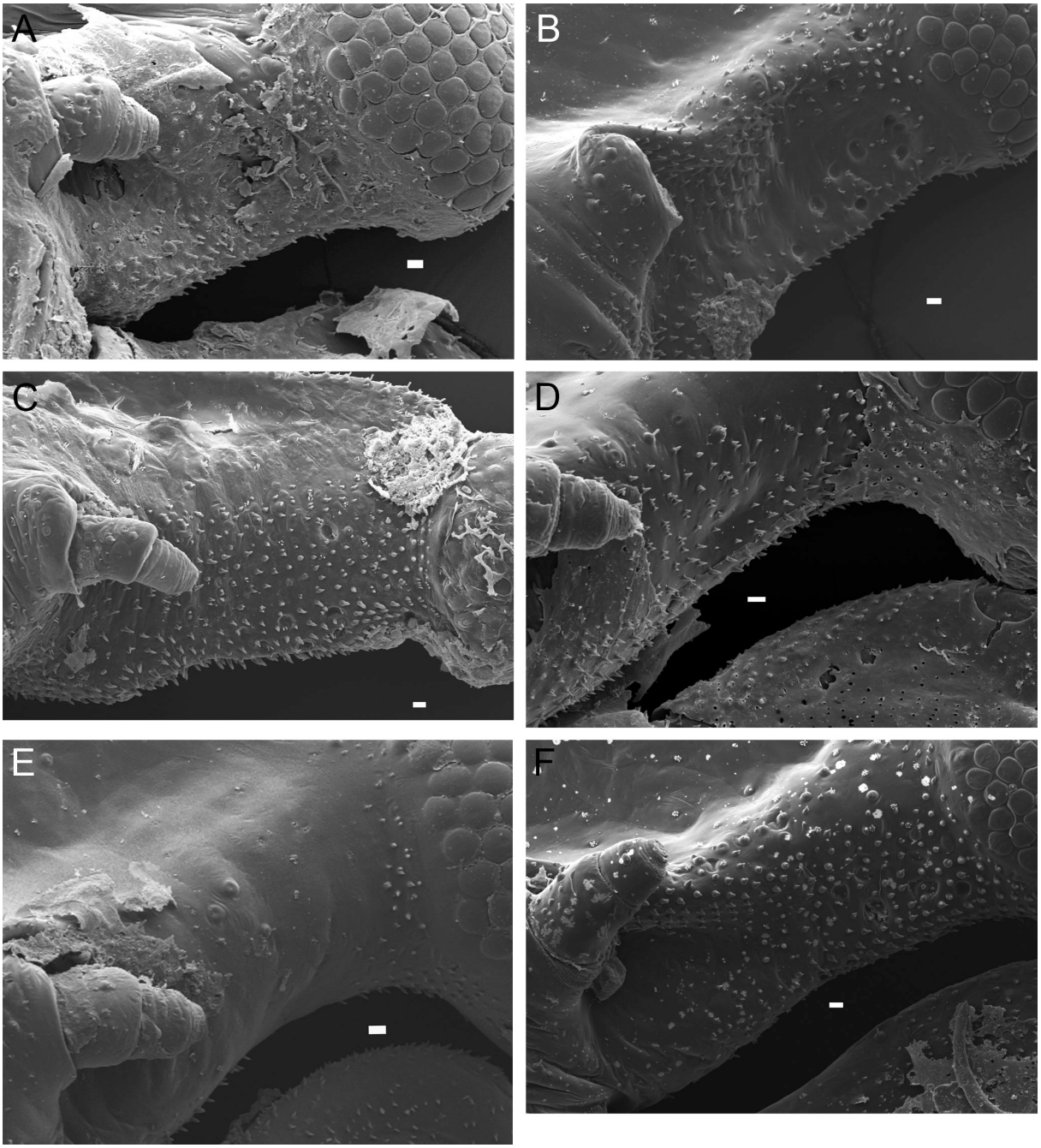
Supplement 3. Fig. 6: Antennae in Peloridiidae, caudal view (viewer's facing the posterior surface of the flagellum, the ventral side is above and the dorsal below). A – *Oiophysa ablusa*, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophyes cascus*, E – *Xenophyes kinlochensis*, F – *Xenophyes rhachilophus*, G – *Xenophysella greensladeae*, H – *Xenophysella stewartensis*. Scale bars: 10 µm.



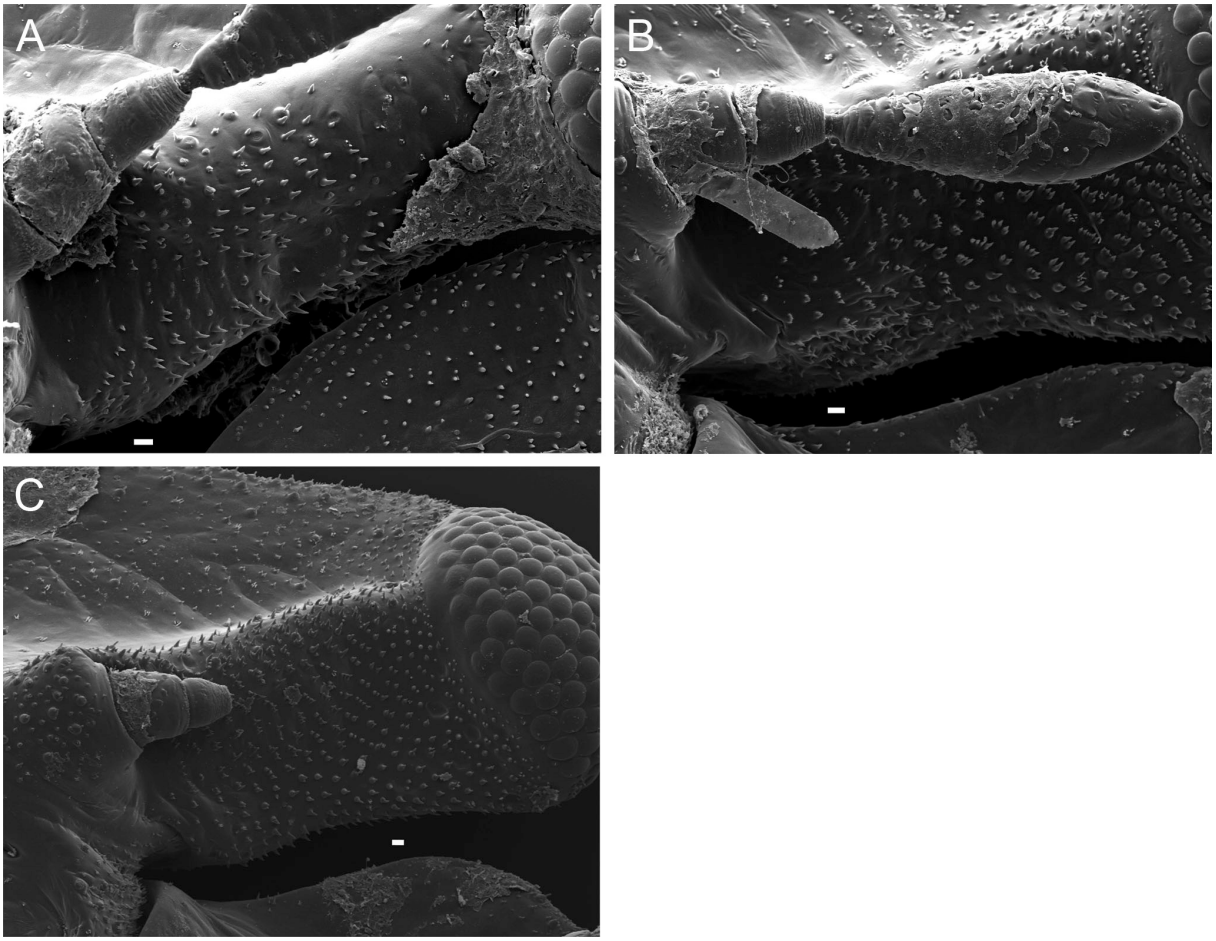
Supplement 3. Fig. 7: Genal area in Peloridiidae, ventral view. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecellus fidelis*, E – *Hemiodoecus acutus*, F – *Hemiodoecus crassus*, G – *Hemiodoecus leai*. Scale bars: 10 µm.



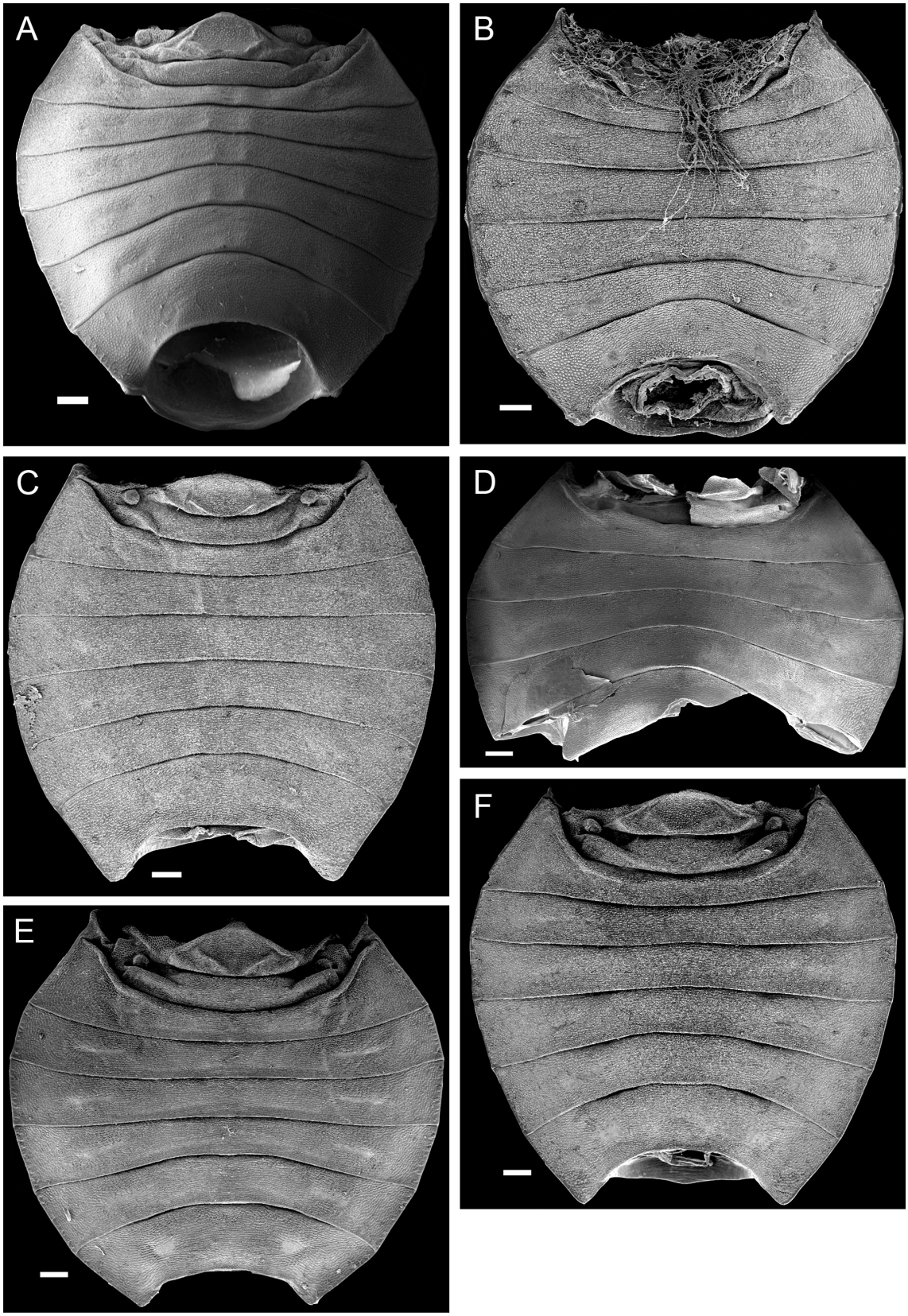
Supplement 3. Fig. 8: Genal area in Peloridiidae, ventral view. A – *Hemiowoodwardia wilsoni*, B – *Idophysa chonos*, C – *Peloridium hammoniorum*, D – *Peloridium pomponorum*, E – *Pantinia darwini*, F – *Peloridora holgatei*. Scale bars: 10 µm.



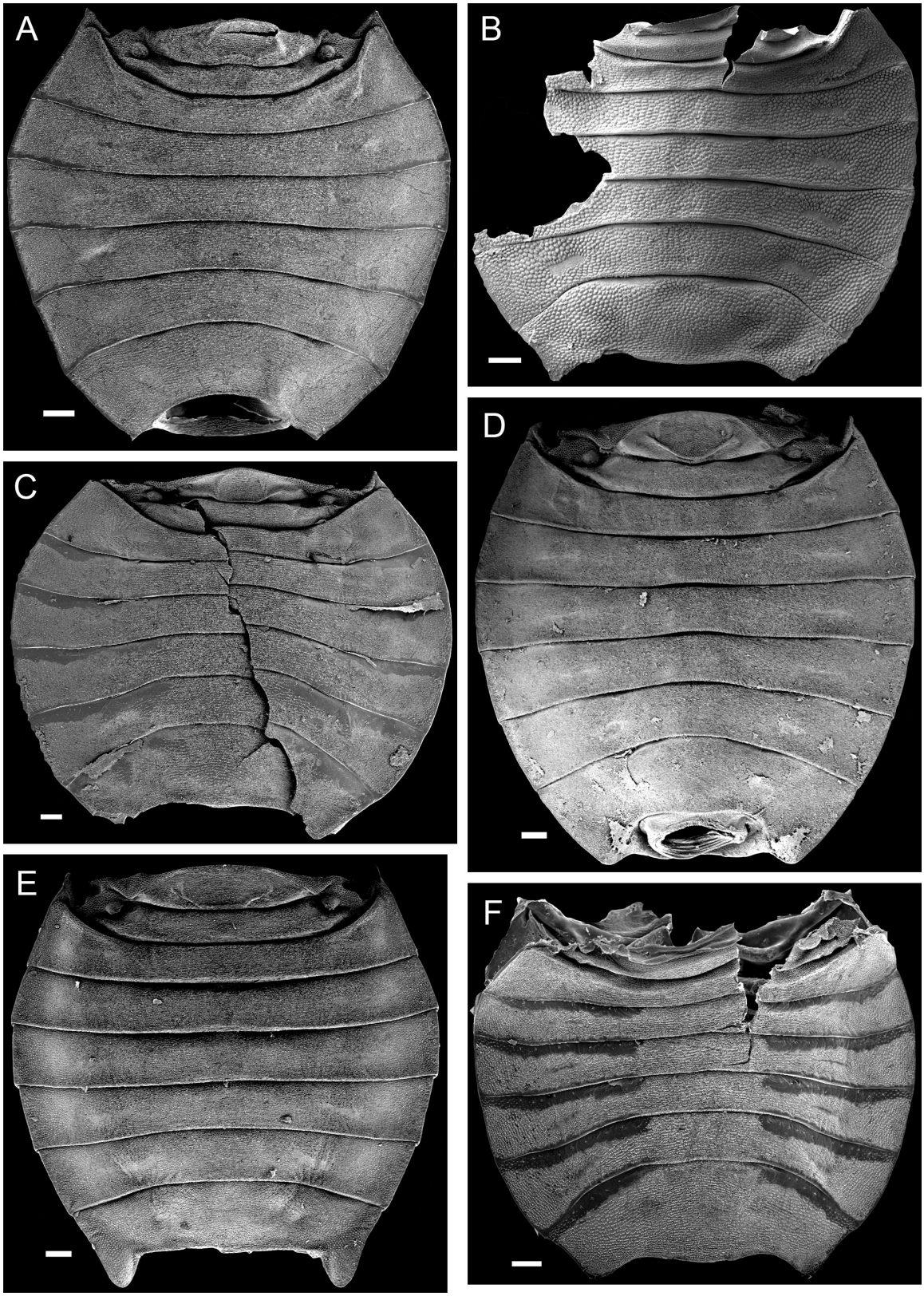
Supplement 3. Fig. 9: Genal area in Peloridiidae, ventral view. A – *Oiophysa ablusa*, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophyes cascus*, E – *Xenophyes cascus*, F – *Xenophyes kinlochensis*. Scale bars: 10 µm.



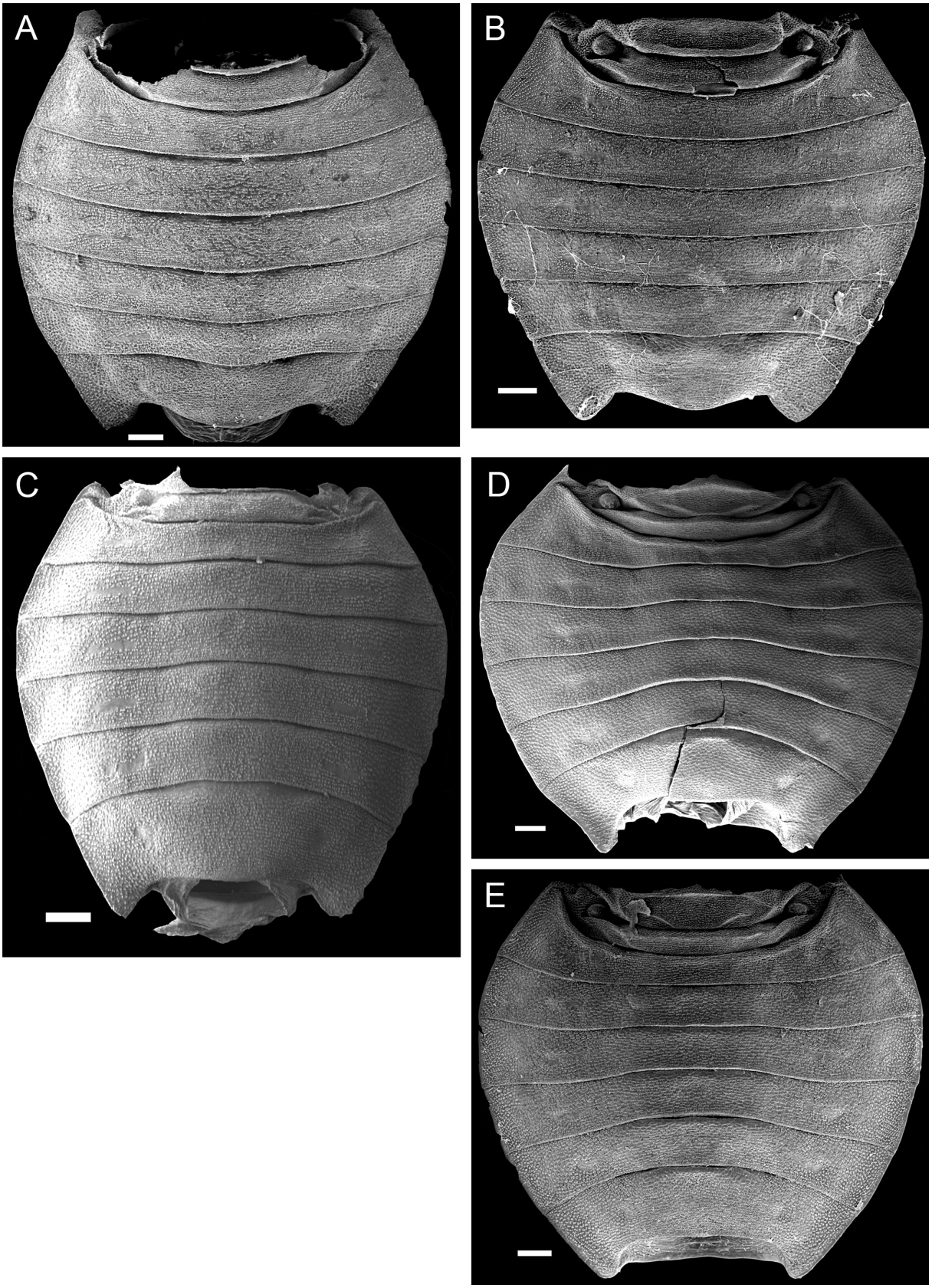
Supplement 3. Fig. 10: Genal area in Peloridiidae, ventral view. A – *Xenophyes rhachilophus*, B – *Xenophysella greensladeae*, C – *Xenophysella stewartensis*. Scale bars: 10 µm.



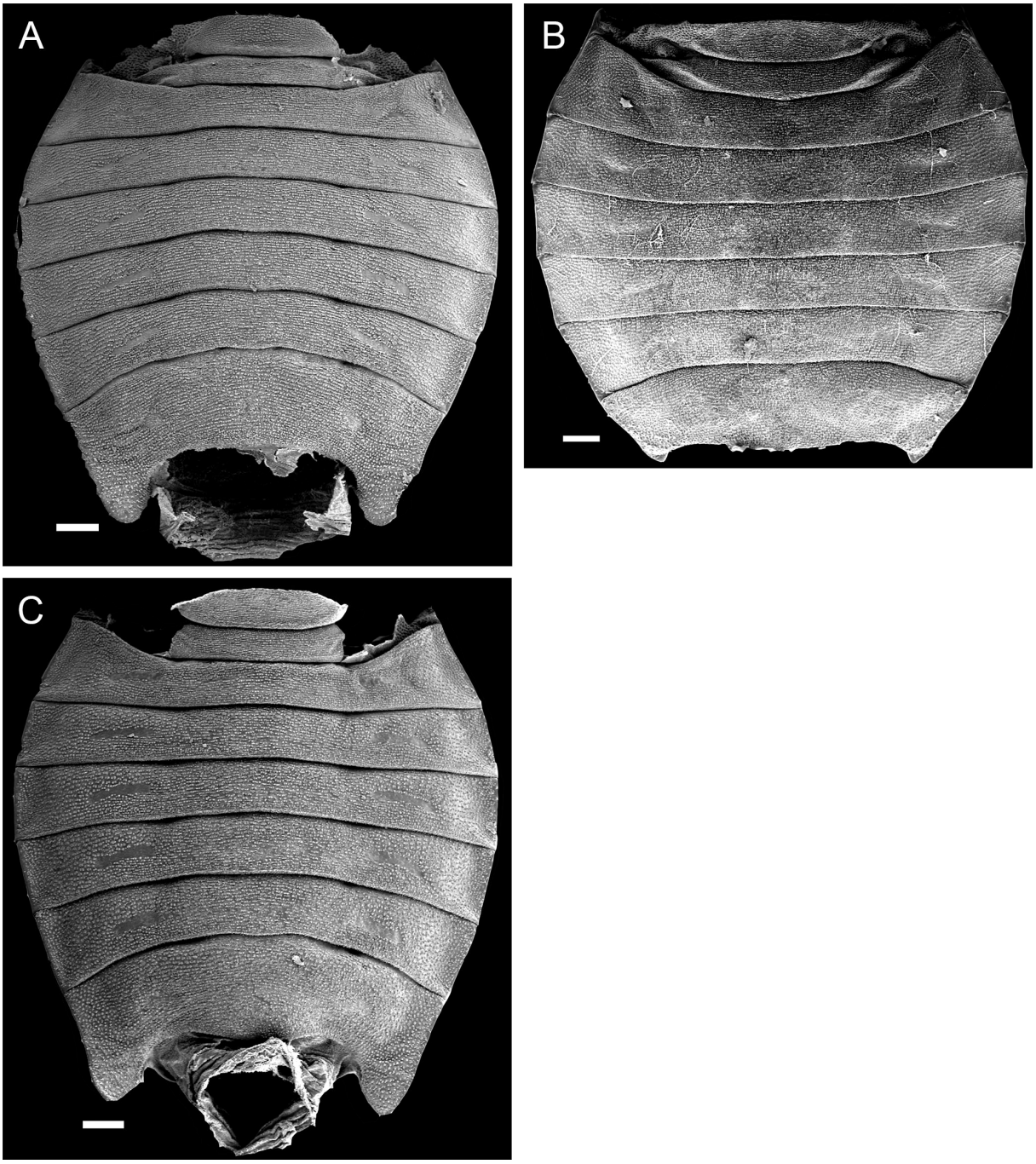
Supplement 3. Fig. 11: Dorsal abdomen in Peloridiidae. A – *Hackeriella brachycephala*, B – *Hackeriella veitchi*, C – *Hemiodoecellus fidelis*, D – *Hemiodoecus acutus*, E – *Hemiodoecus leai*, F – *Hemiodoecus crassus*. Scale bars: 100 µm.



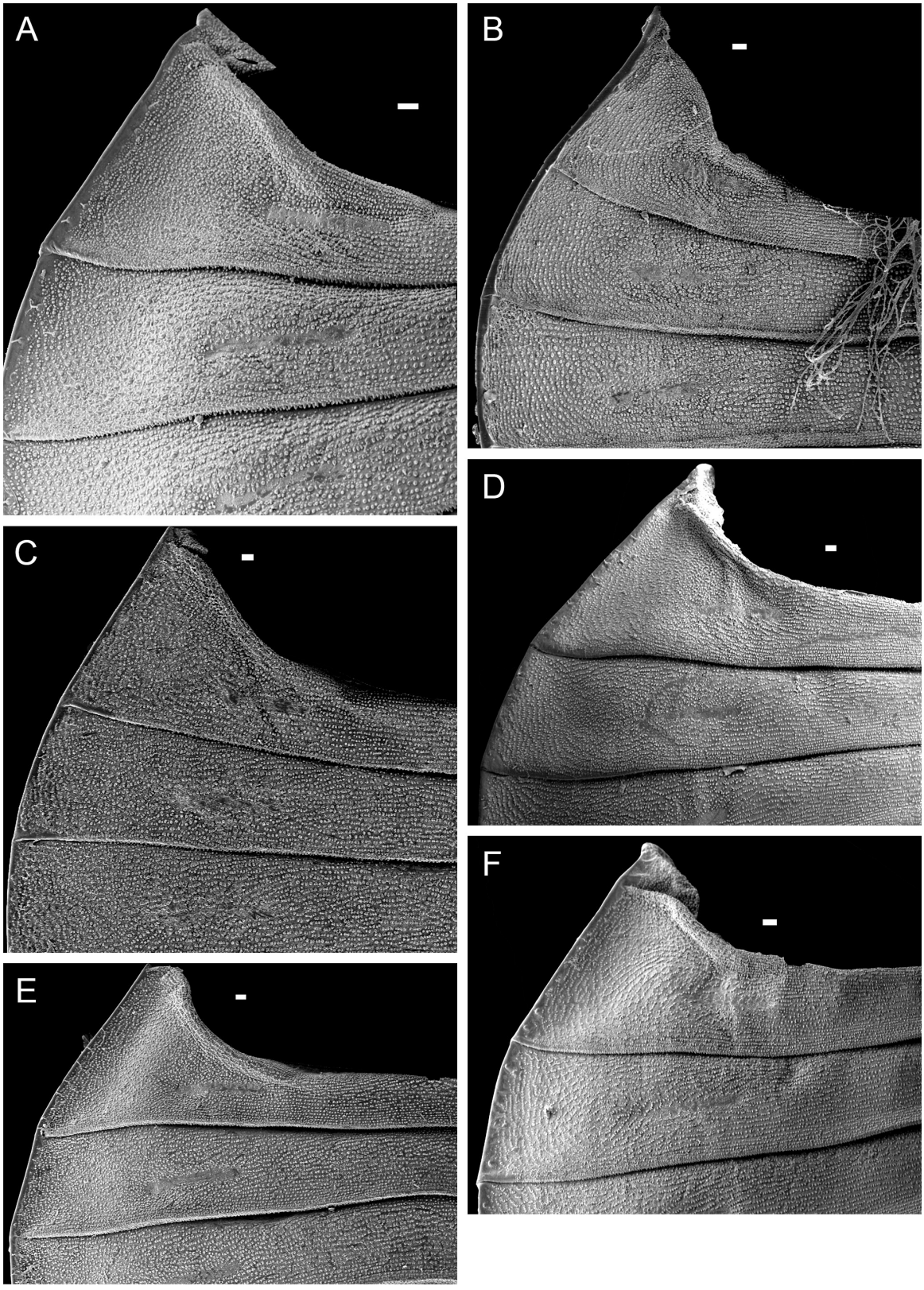
Supplement 3. Fig. 12: Dorsal abdomen in Peloridiidae. A – *Hemiowoodwardia wilsoni*, B – *Idophysa chonos*, C – *Pantinia darwini*, D – *Peloridium hammoniorum*, E – *Peloridium pomponorum*, F – *Peloridora holdgatei*. Scale bars: 100 µm.



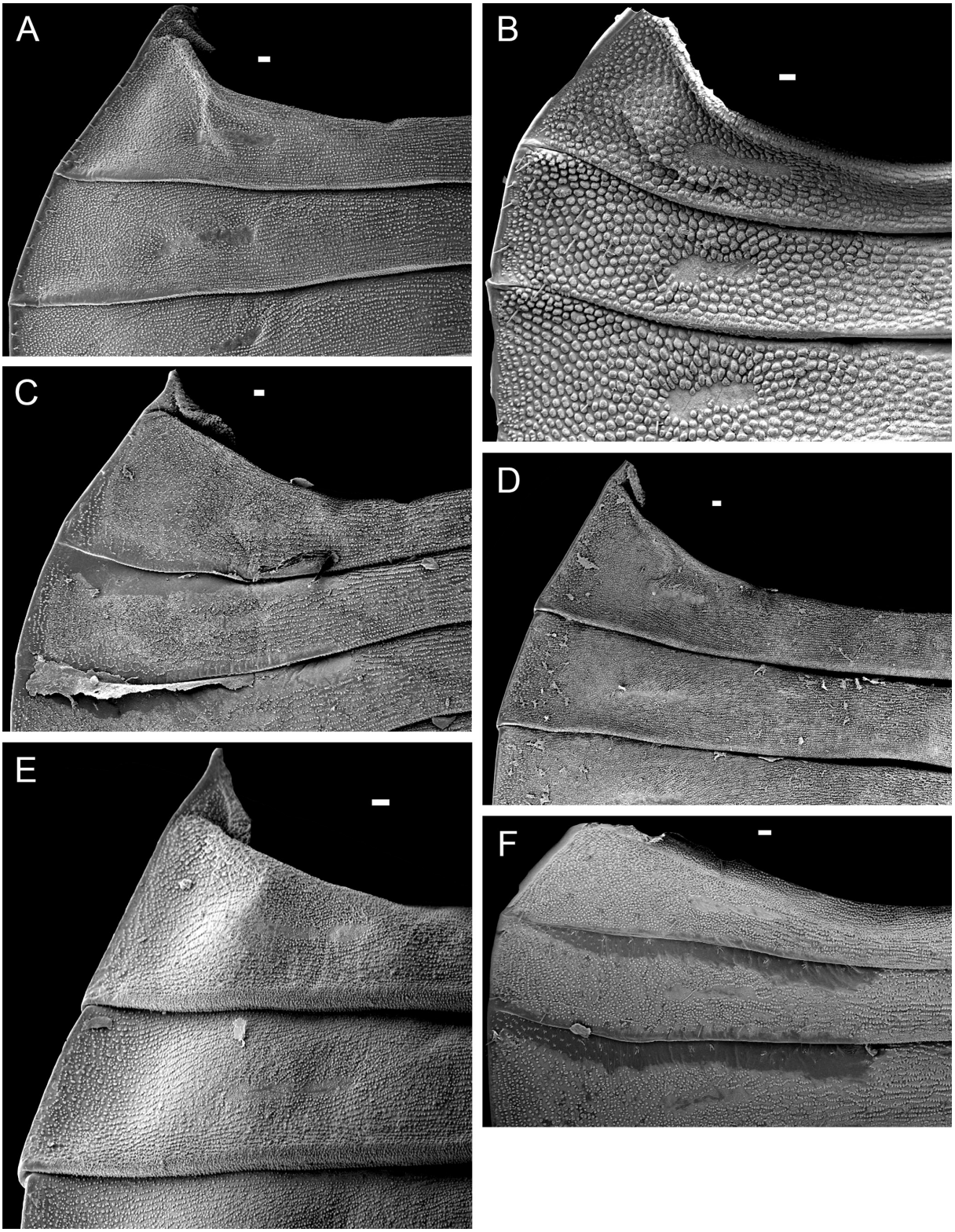
Supplement 3. Fig. 13: Dorsal abdomen in Peloridiidae. A – *Oiophysa ablusa*, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophysella greensladeae*, E – *Xenophysella stewartensis*. Scale bars: 100 µm.



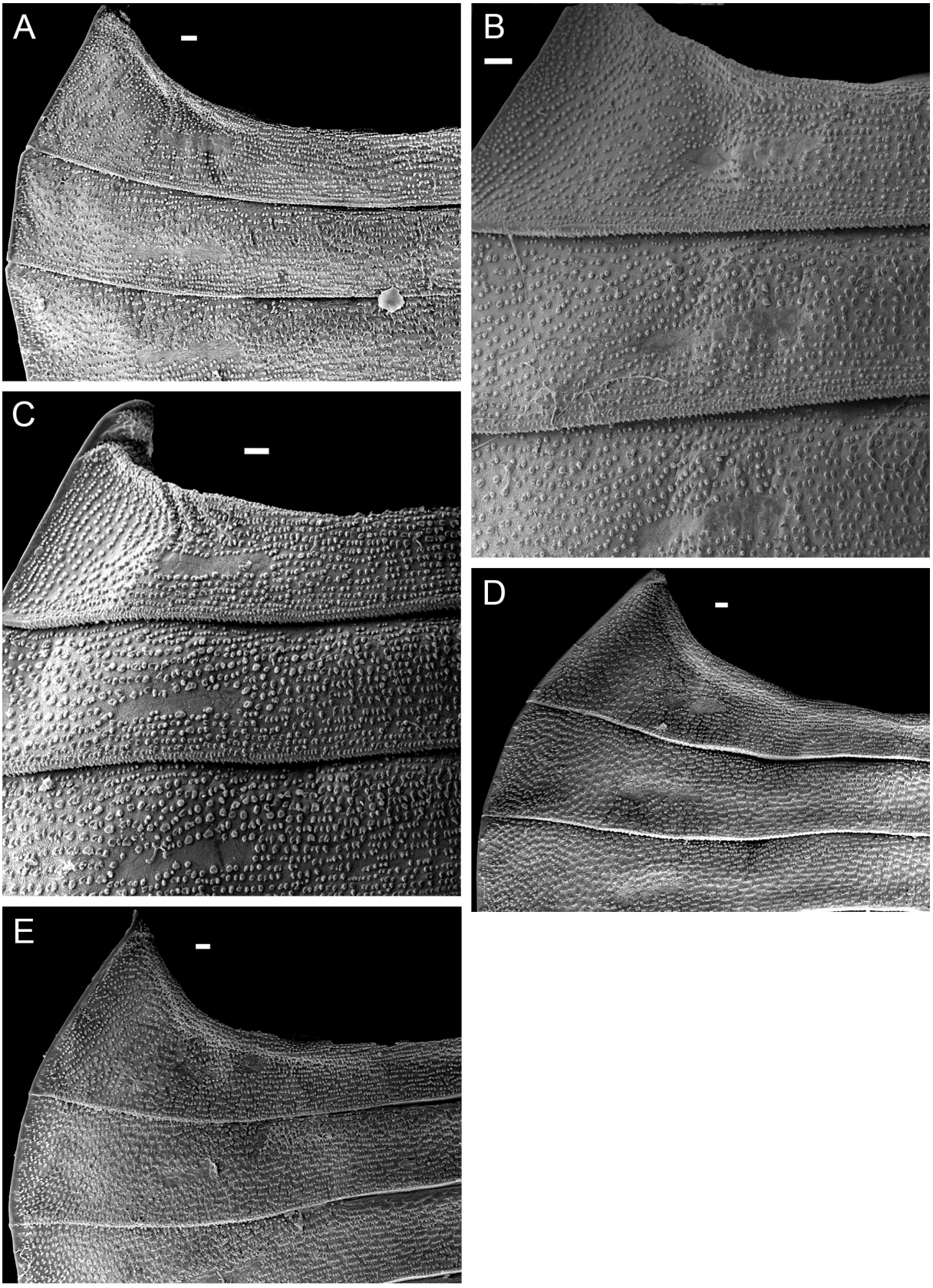
Supplement 3. Fig. 14: Dorsal abdomen in Peloridiidae. A – *Xenophyes cascus*, B – *Xenophyes kinlochensis*, C – *Xenophyes rhachilophus*. Scale bars: 100 µm.



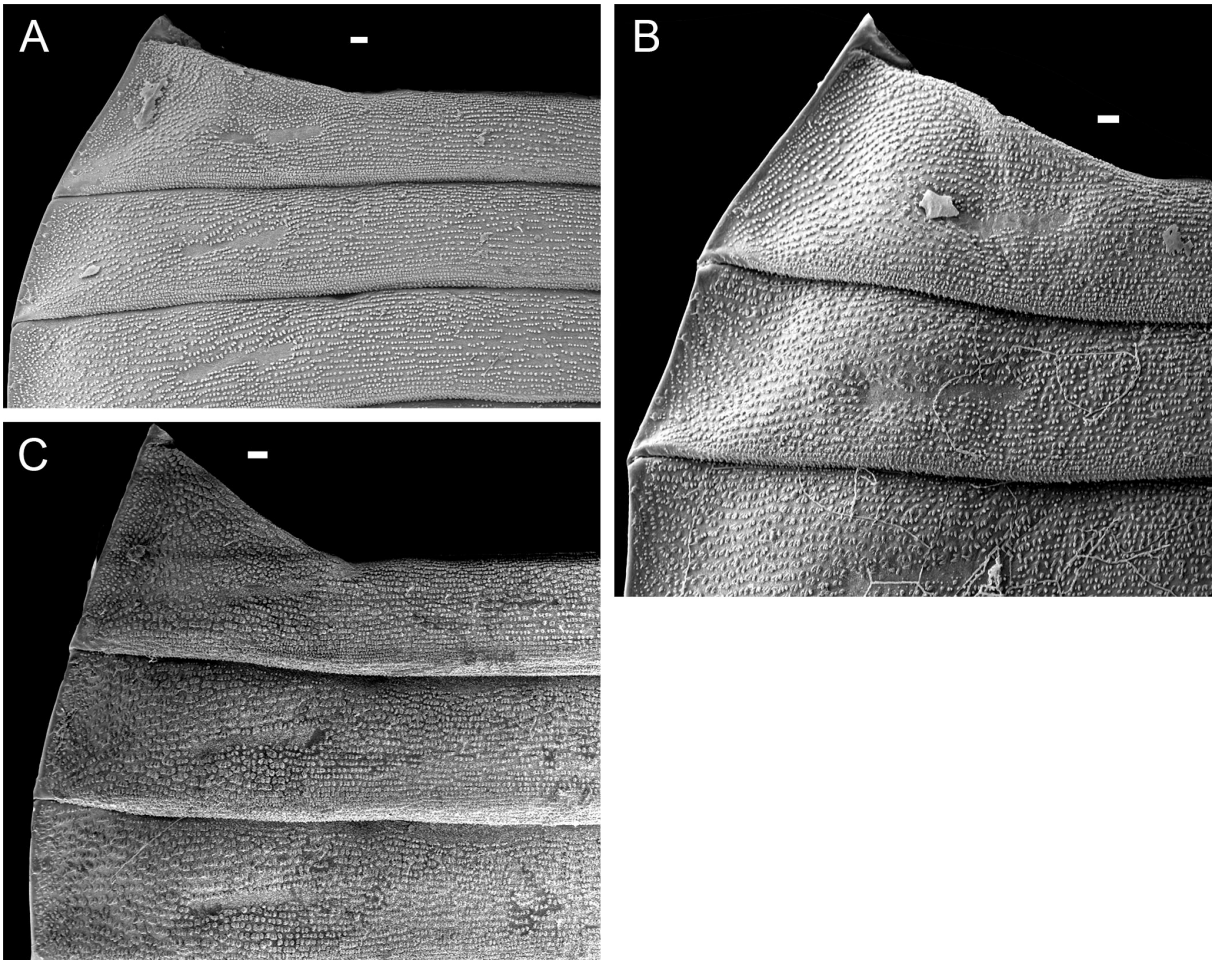
Supplement 3. Fig. 15: First abdominal tergites in Peloridiidae. A – *Hackeriella brachycephala*, B – *Hackeriella veitchi*, C – *Hemiodoecellus fidelis*, D – *Hemiodoecus acutus*, E – *Hemiodoecus crassus*, F – *Hemiodoecus leai*. Scale bars: 20 µm.



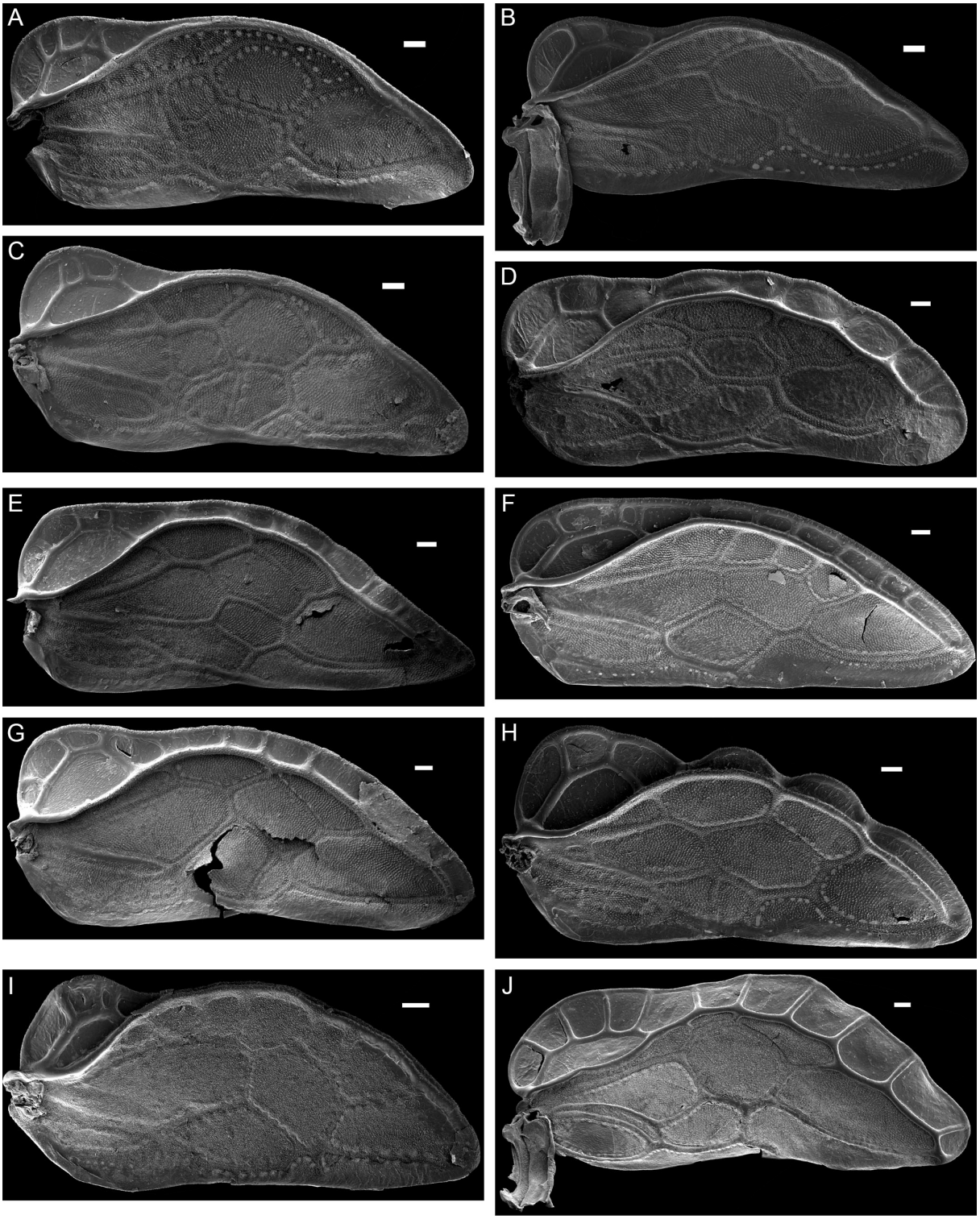
Supplement 3. Fig. 16: First abdominal tergites in Peloridiidae. A – *Hemiowoodwardia wilsoni*, B – *Idophysa chonos*, C – *Pantinia darwini*, D – *Peloridium hammoniorum*, E – *Peloridium pomponorum*, F – *Peloridora holdgatei*. Scale bars: 20 µm.



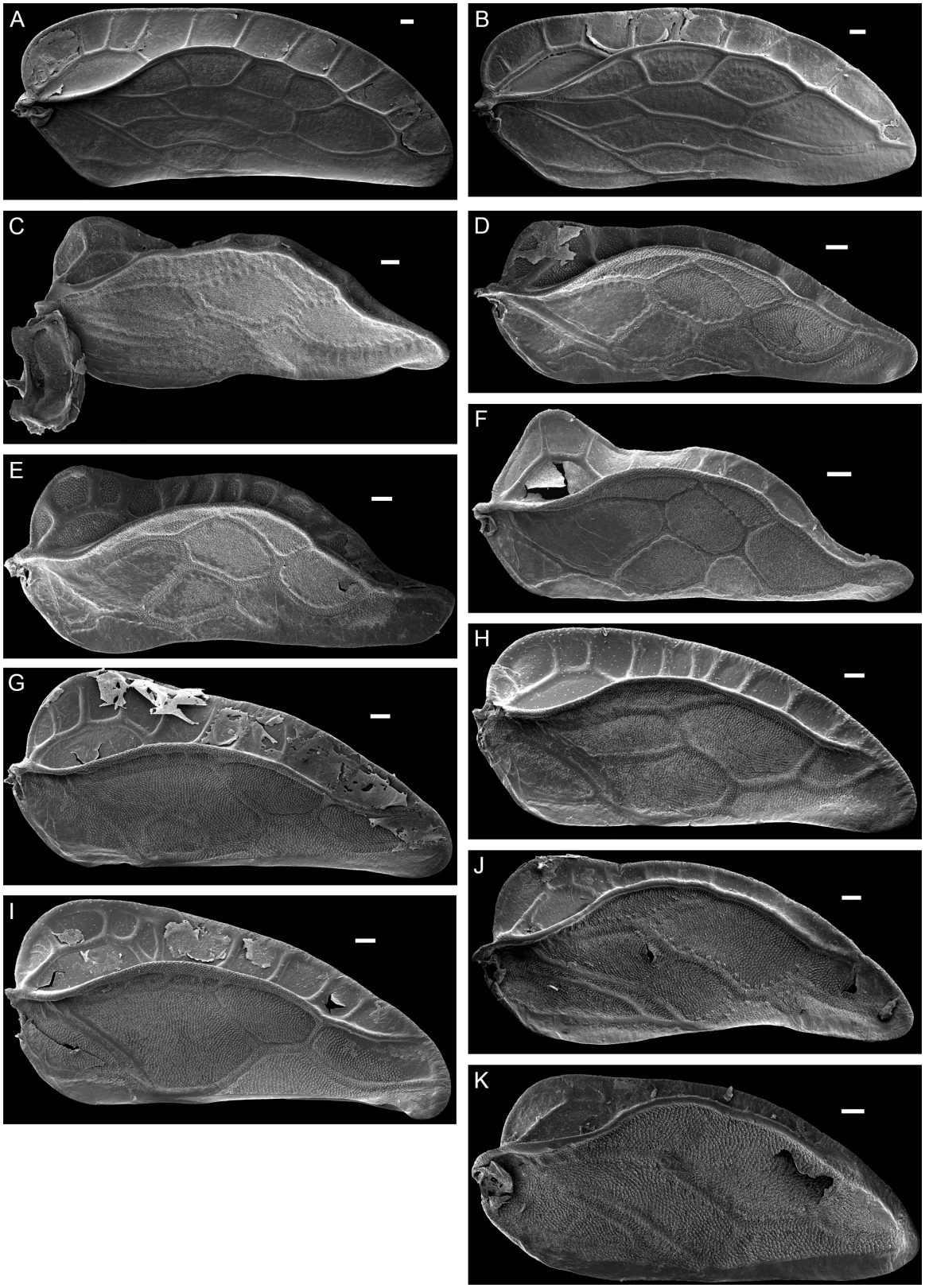
Supplement 3. Fig. 17: First abdominal tergites in Peloridiidae. A – *Oiophysa ablusa*, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophysella greensladeae*, E – *Xenophysella stewartensis*. Scale bars: 20 µm.



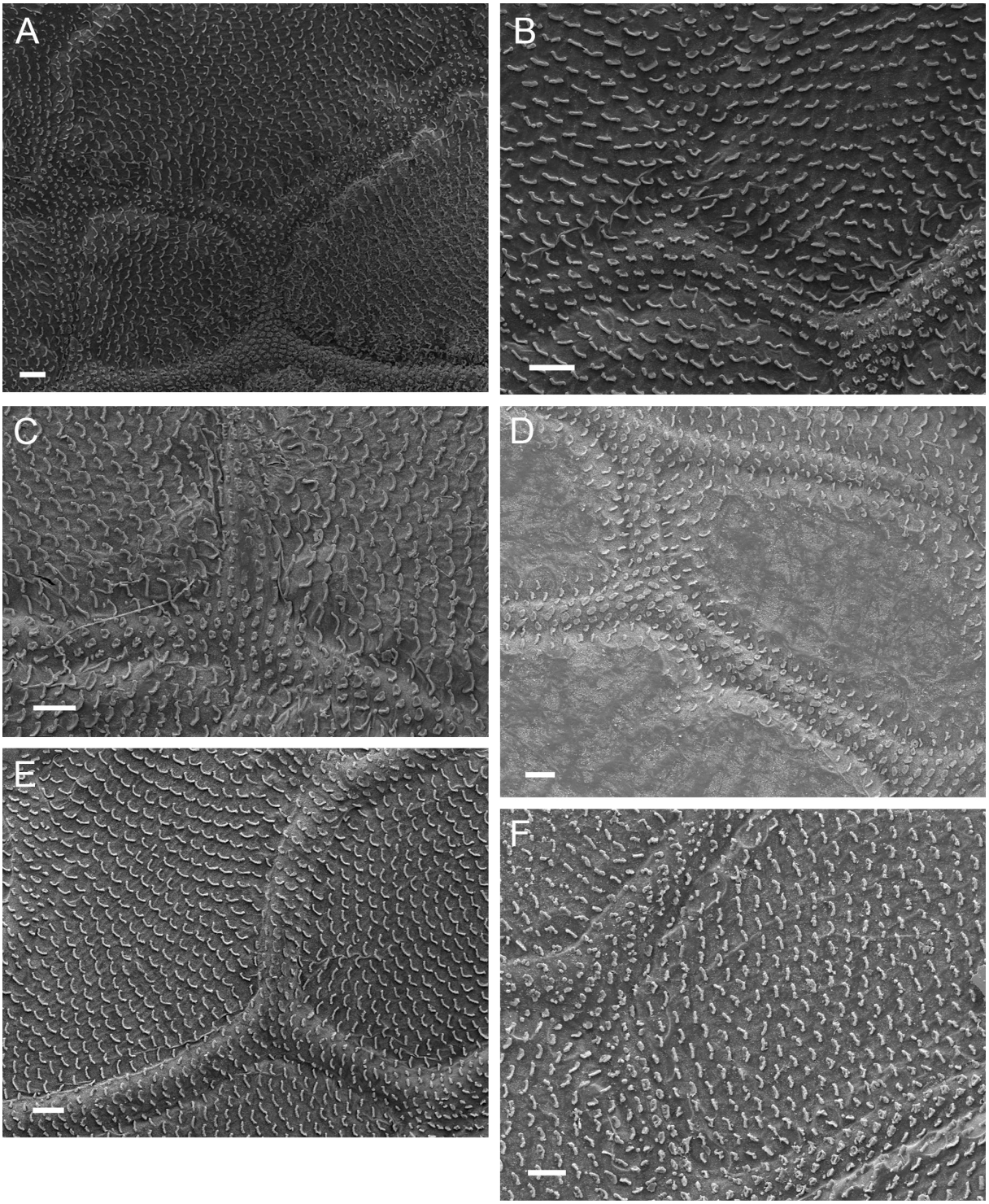
Supplement 3. Fig. 18: First abdominal tergites in Peloridiidae. A – *Xenophyes cascus*, B – *Xenophyes kinlochensis*, C – *Xenophyes rhachilophus*. Scale bars: 20 µm



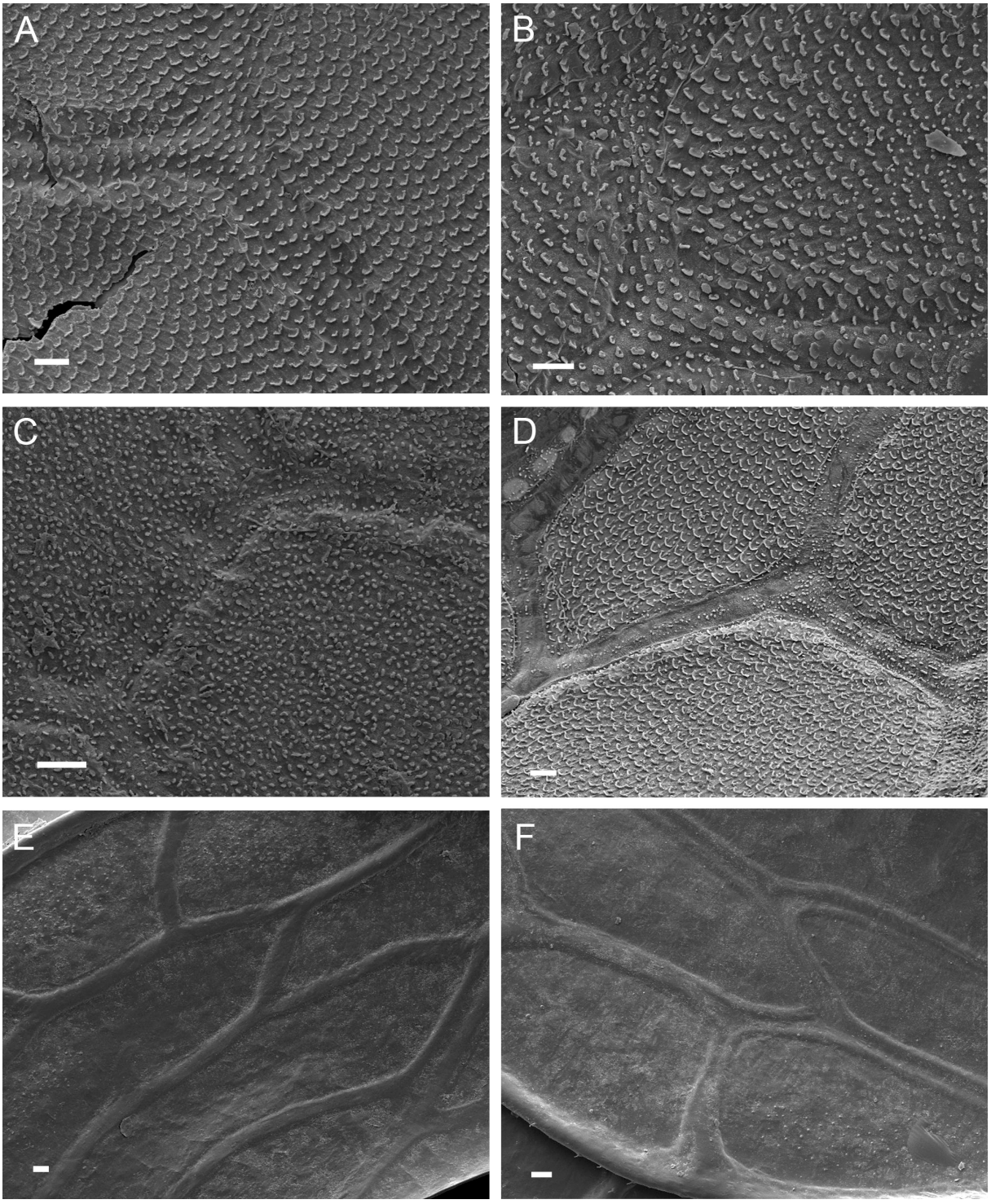
Supplement 3. Fig. 19: Ventral surface of the tegmen in Peloridiidae. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecellus fidelis*, E – *Hemiodoecus acutus*, F – *Hemiodoecus crassus*, G – *Hemiodoecus leai*, H – *Hemiowoodwardia wilsoni*, I – *Idophysa chonos*, J – *Pantinia darwini*. Scale bars: 100 µm.



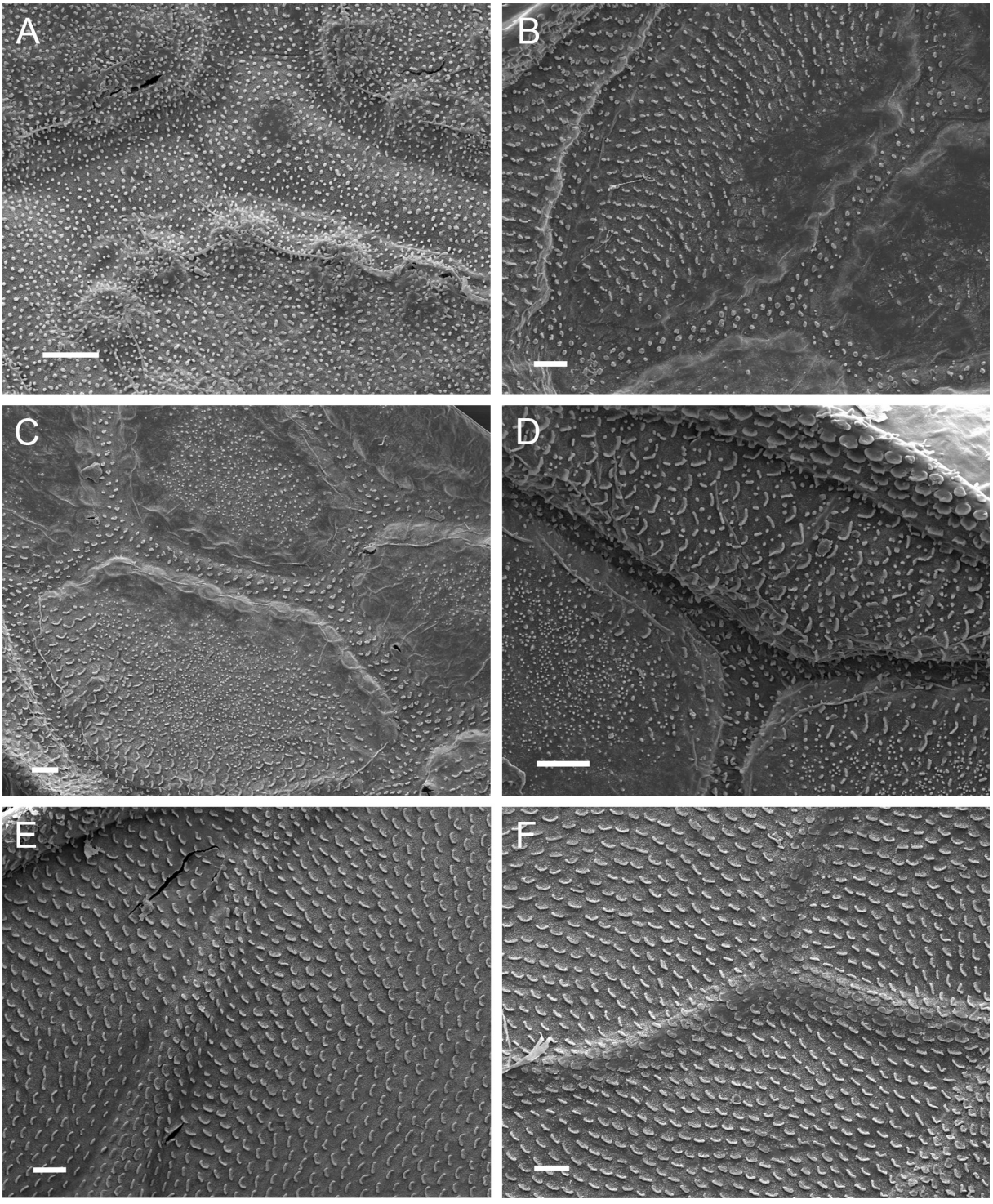
Supplement 3. Fig. 20: Ventral surface of the tegmen in Peloridiidae. A – *Peloridium hammoniorum*, B – *Peloridium pomponorum*, C – *Peloridora holdgatei*, D – *Oiophysa ablusa*, E – *Oiophysa cumberi*, F – *Oiophysa distincta*, G – *Xenophyes cascus*, H – *Xenophyes kinlochensis*, I – *Xenophyes rhachilophus*, J – *Xenophysella greensladeae*, K – *Xenophysella stewartensis*. Scale bars: 100 µm.



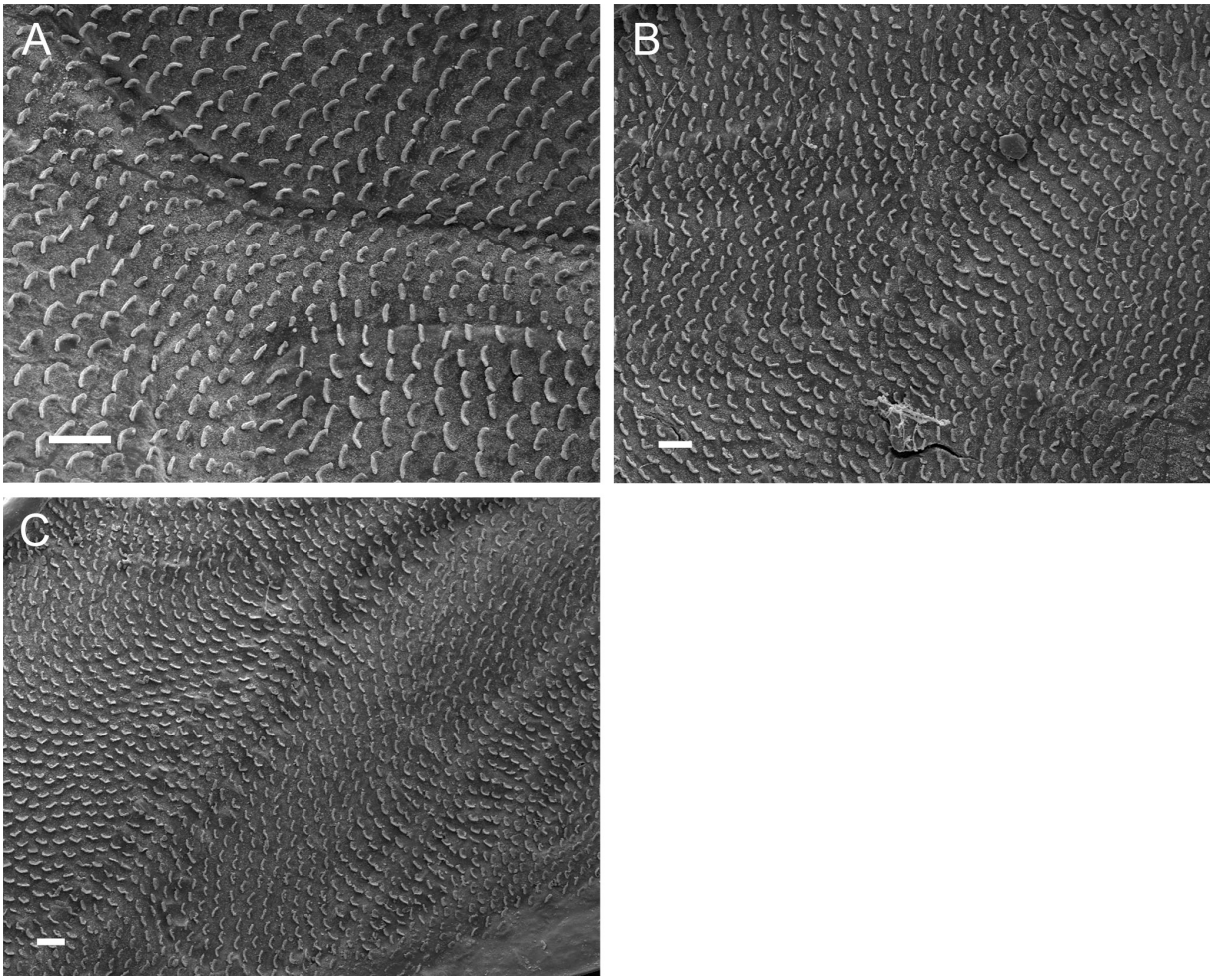
Supplement 3. Fig. 21: Ventral surface of the tegmen in Peloridiidae, detail. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecellus fidelis*, E – *Hemiodoecus acutus*, F – *Hemiodoecus crassus*. Scale bars: 30 µm.



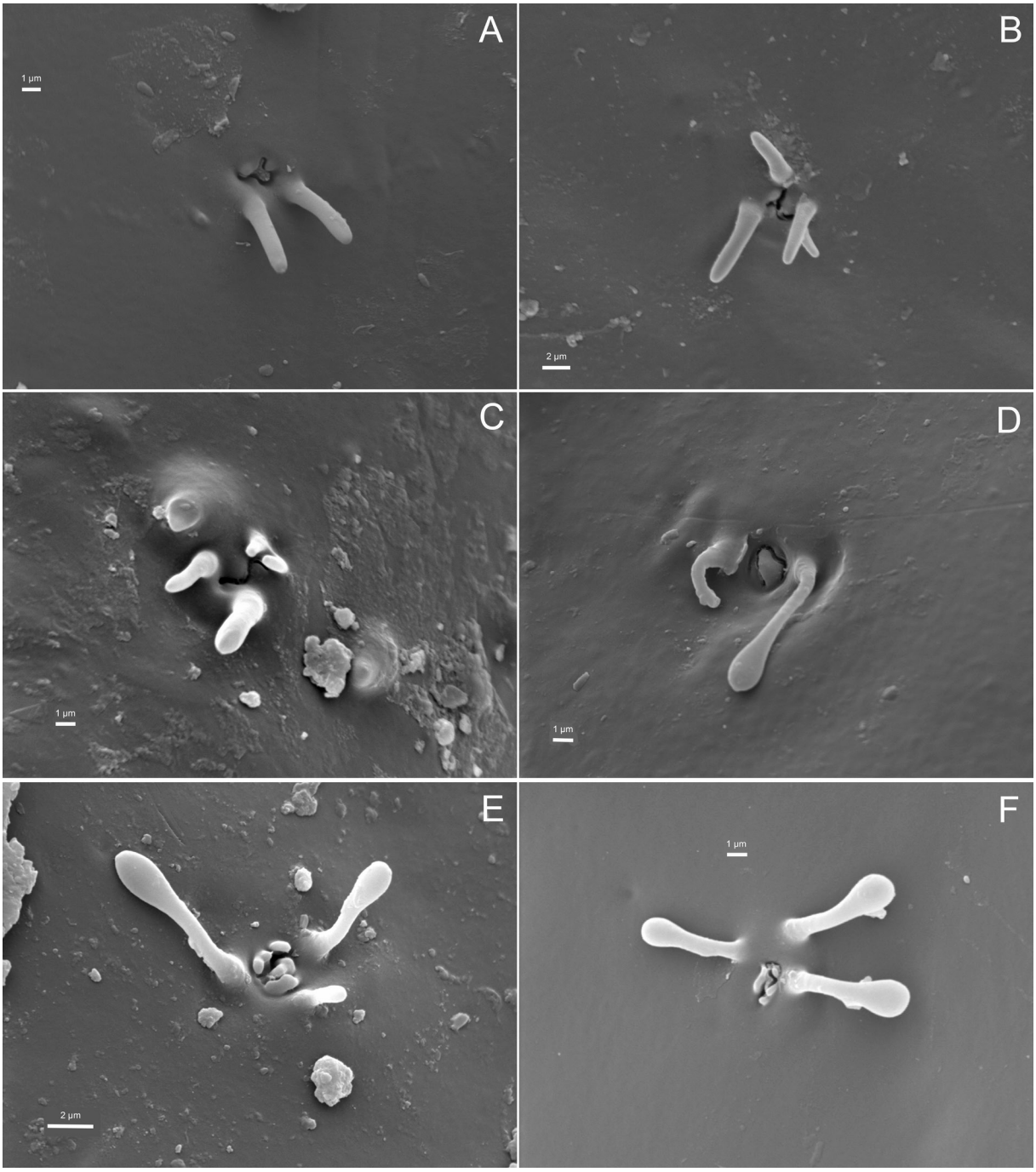
Supplement 3. Fig. 22: Ventral surface of the tegmen in Peloridiidae, detail. A – *Hemiodoecus* leai, B – Hemiowoodwardia *wilsoni*, C – *Idophysa chonos*, D – *Pantinia darwini*, E – *Peloridium hammoniorum*, F – *Peloridium pomponorum*. Scale bars: 30 µm.



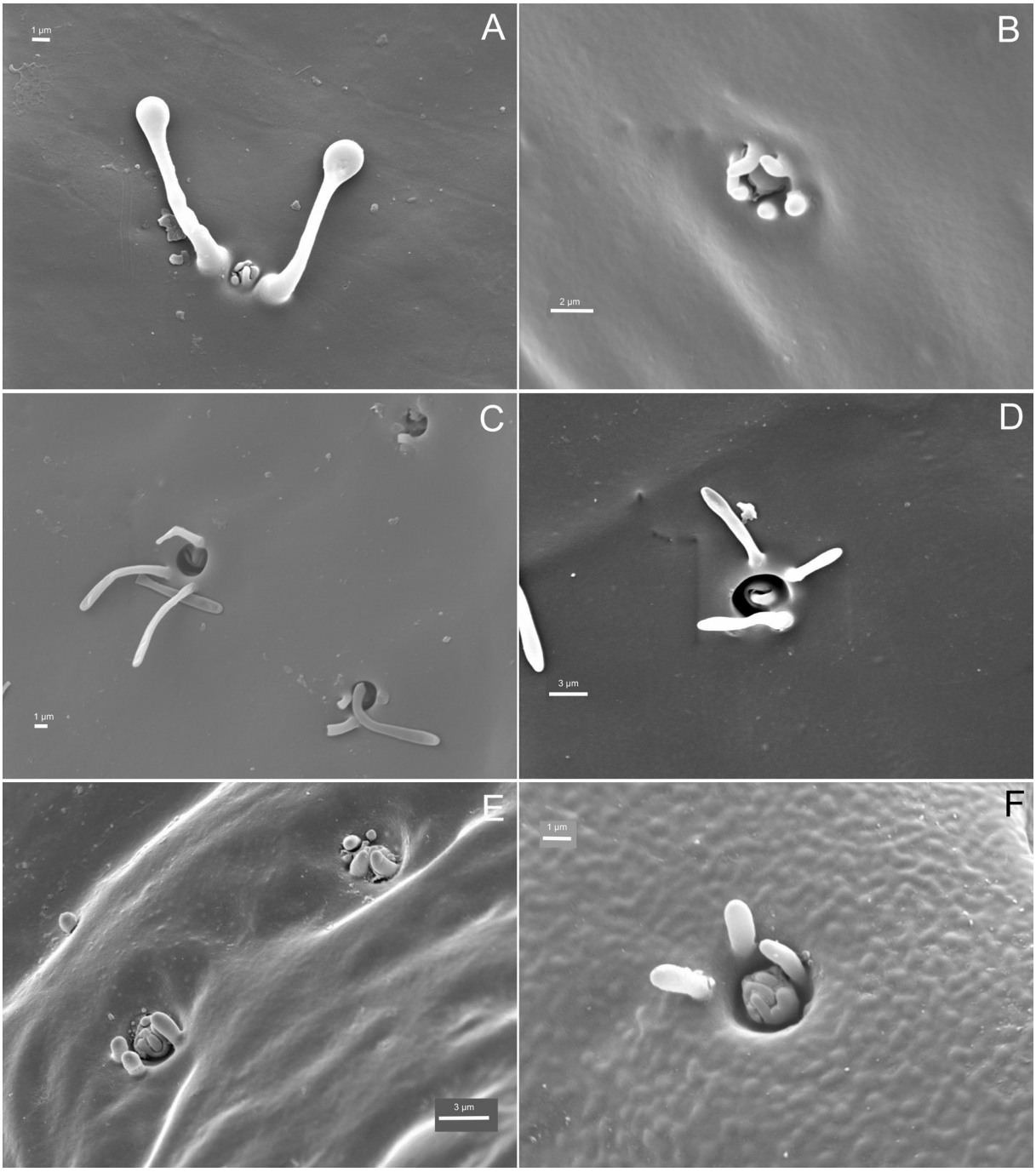
Supplement 3. Fig. 23: Ventral surface of the tegmen in Peloridiidae, detail. A – *Peloridora holdgatei*, B – *Oiophysa ablusa*, C – *Oiophysa cumberi*, D – *Oiophysa distincta*, E – *Xenophyes cascus*, F – *Xenophyes kinlochensis*. Scale bars: 30 µm.



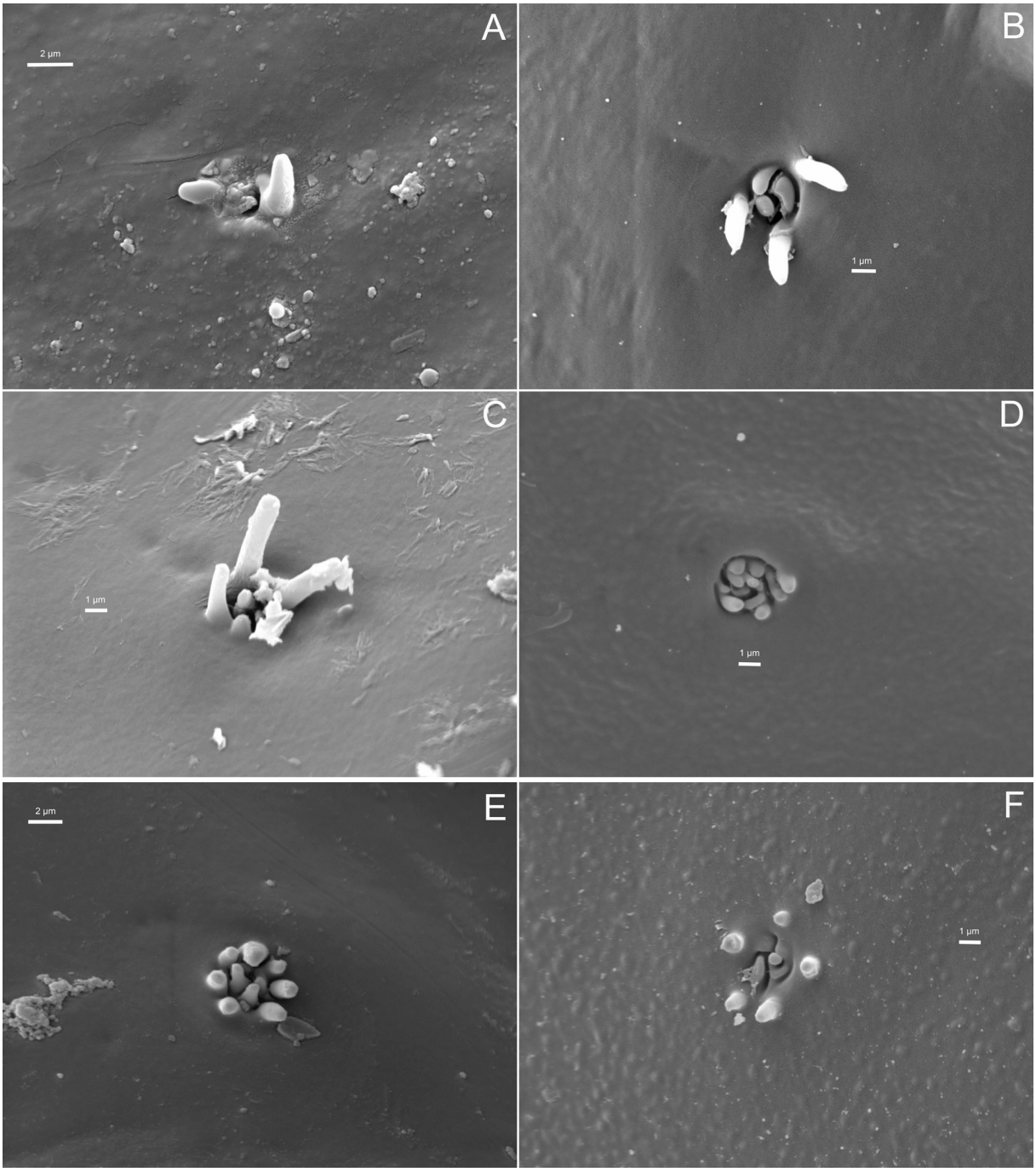
Supplement 3. Fig. 24: Ventral surface of the tegmen in Peloridiidae, detail. A – *Xenophyes rhachilophus*, B – *Xenophysella greensladeae*, C – *Xenophysella stewartensis*. Scale bars: 30 µm.



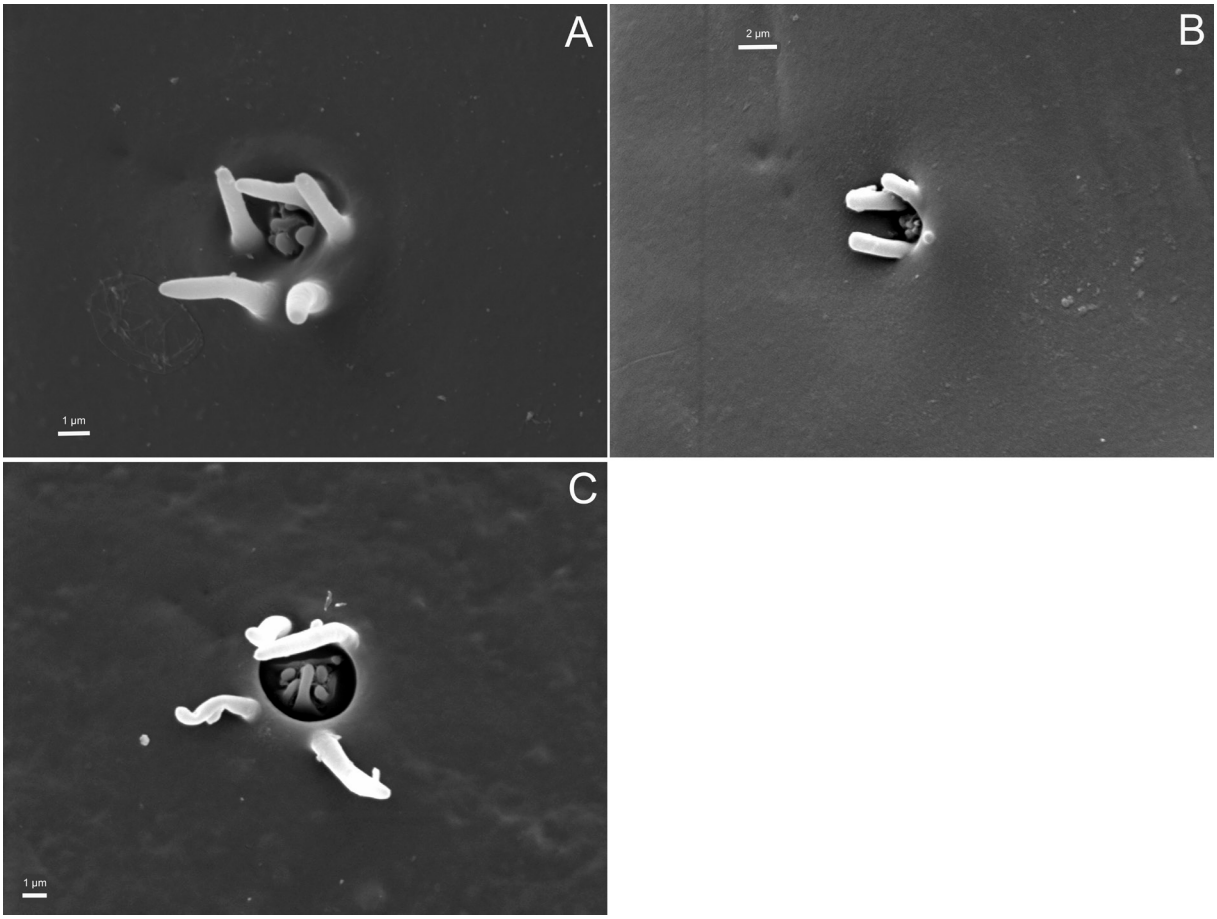
Supplement 3. Fig. 25: Integumental glands in Peloridiidae. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecus acutus*, E – *Hemiodoecus crassus*, F – *Hemiodoecus leai*.



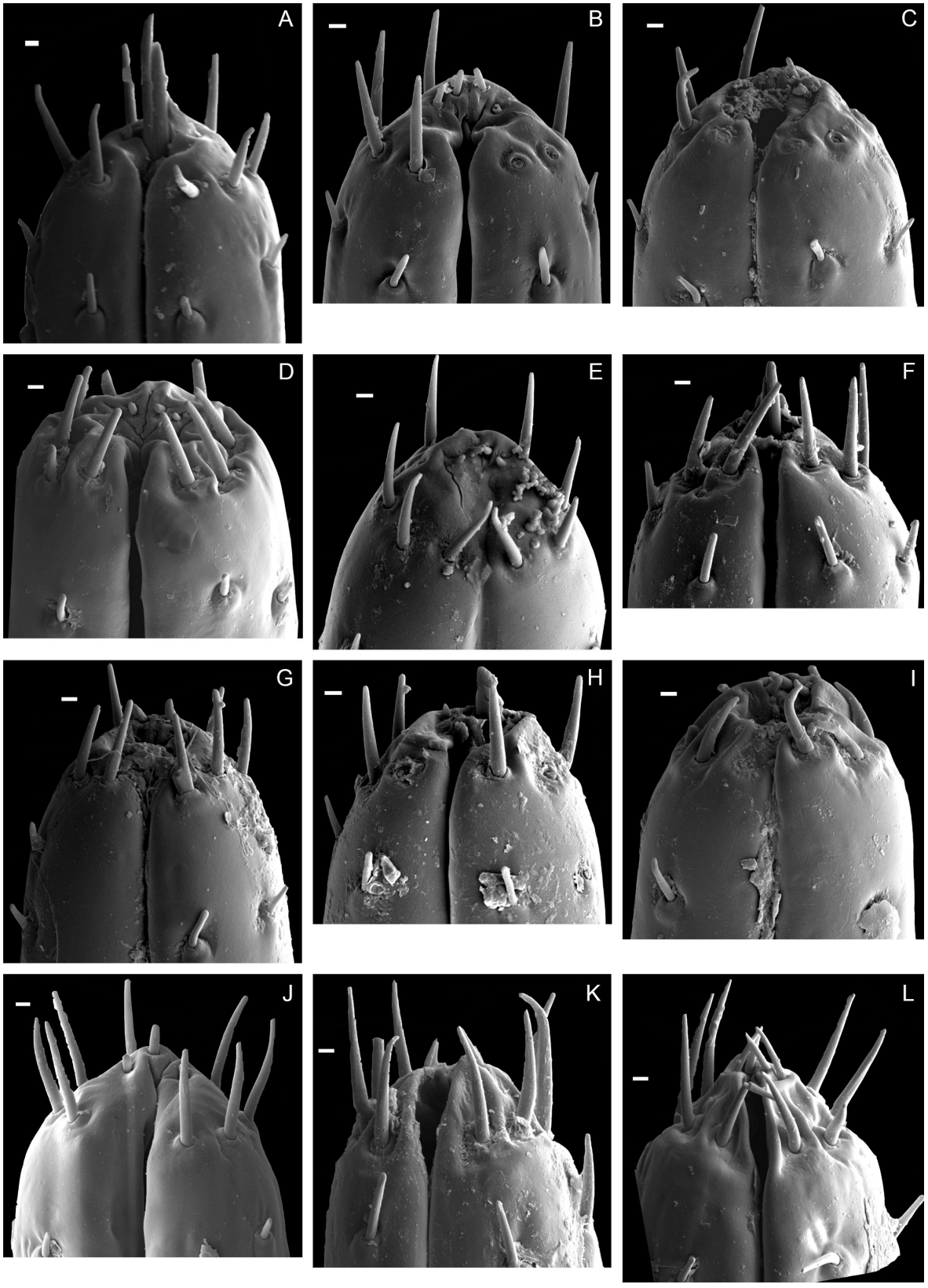
Supplement 3. Fig. 26: Integumental glands in Peloridiidae. A – *Hemiwoodwardia wilsoni*, B – *Hemiodoecellus fidelis*, C – *Idophysa chonos*, D – *Peloridora holdgatei*, E – *Peloridium hammoniorum*, F – *Peloridium pomponorum*.



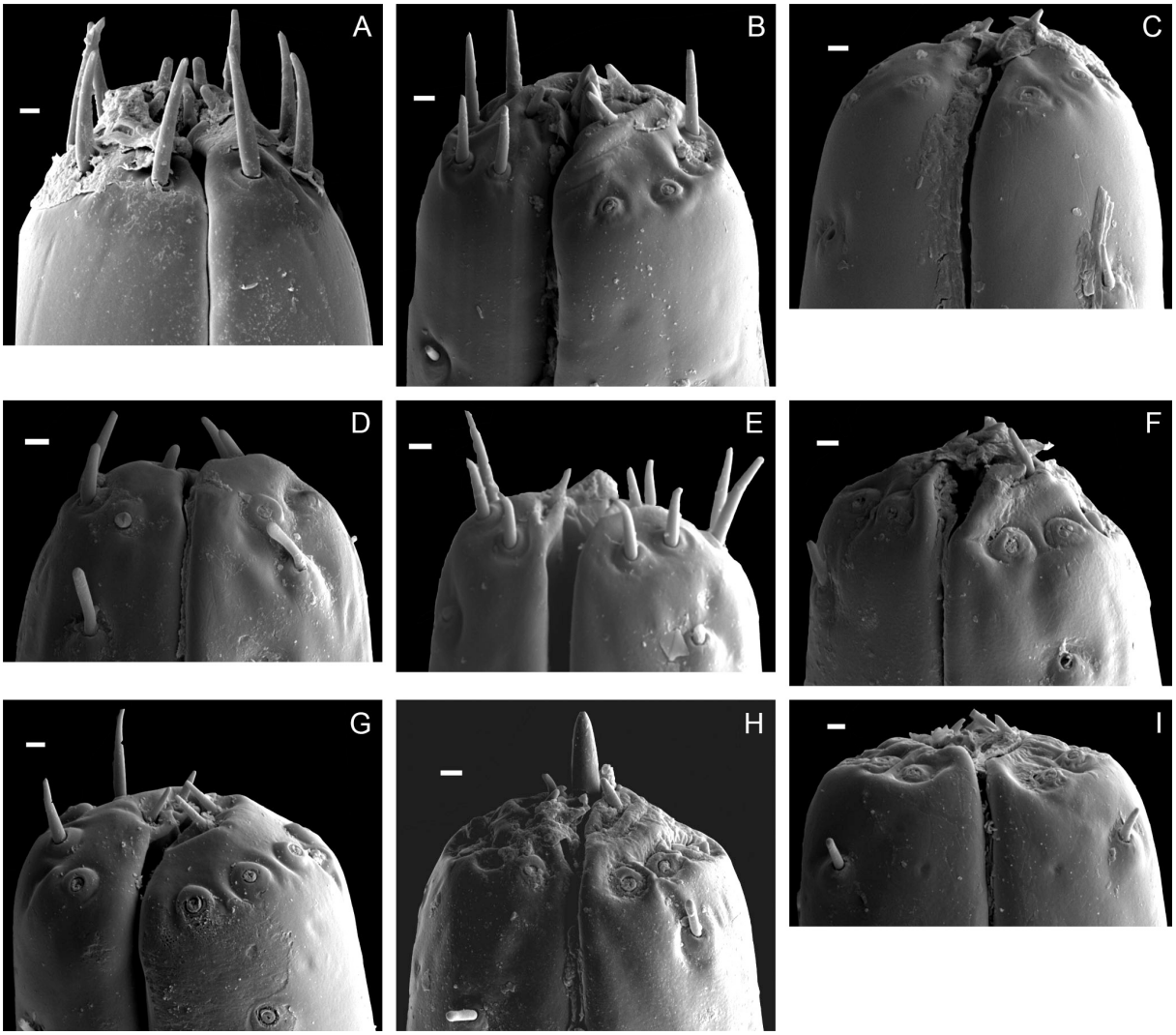
Supplement 3. Fig. 27: Integumental glands in Peloridiidae. A – Oiophysa ablusa, B – *Oiophysa cumberi*, C – *Oiophysa distincta*, D – *Xenophyes cascus*, E – *Xenophyes kinlochensis*, F – *Xenophyes rhachilophus*.



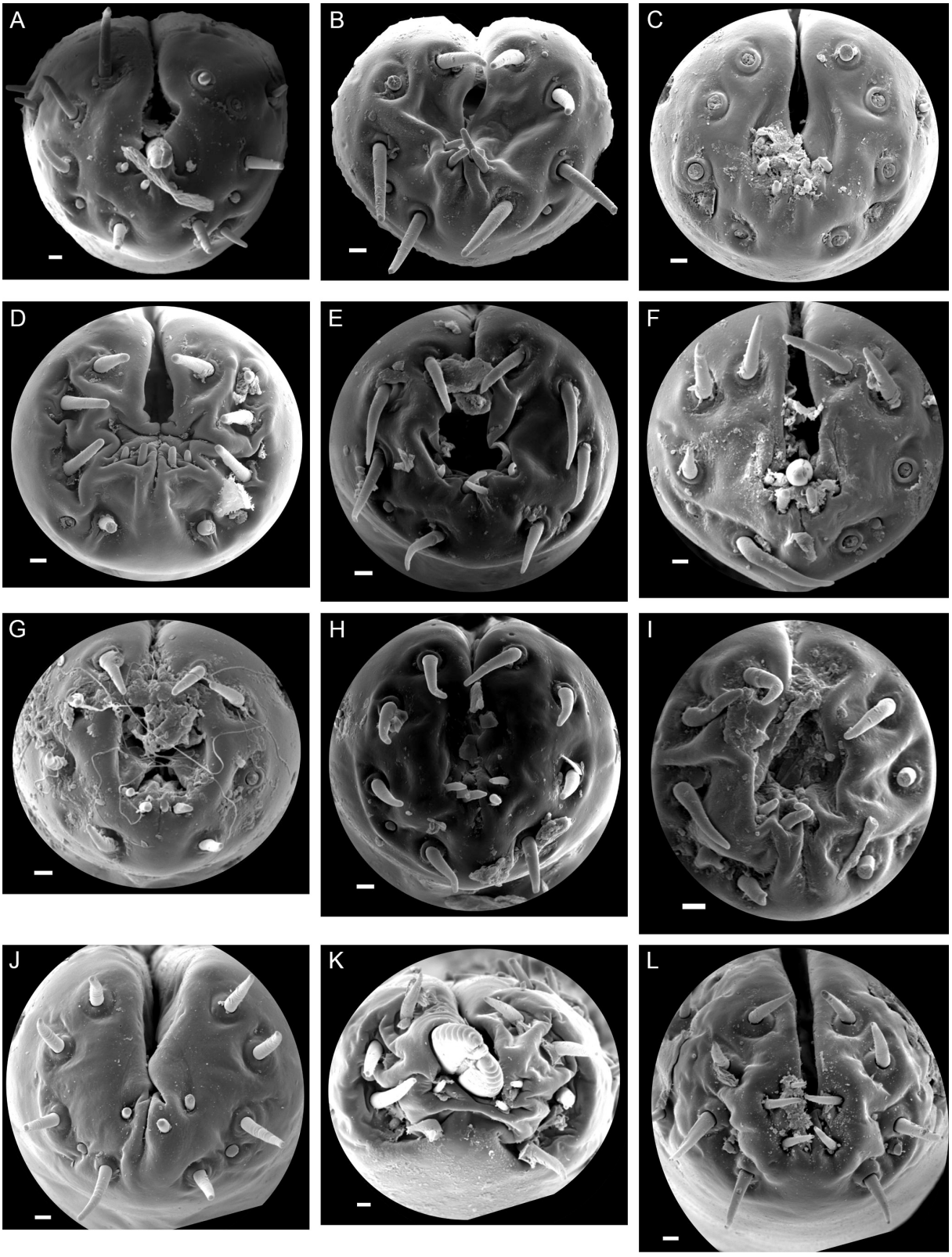
Supplement 3. Fig. 28: Integumental glands in Peloridiidae. A – *Xenophysella greensladeae*, B – *Xenophysella stewartensis*, C – *Pantinia darwini*.



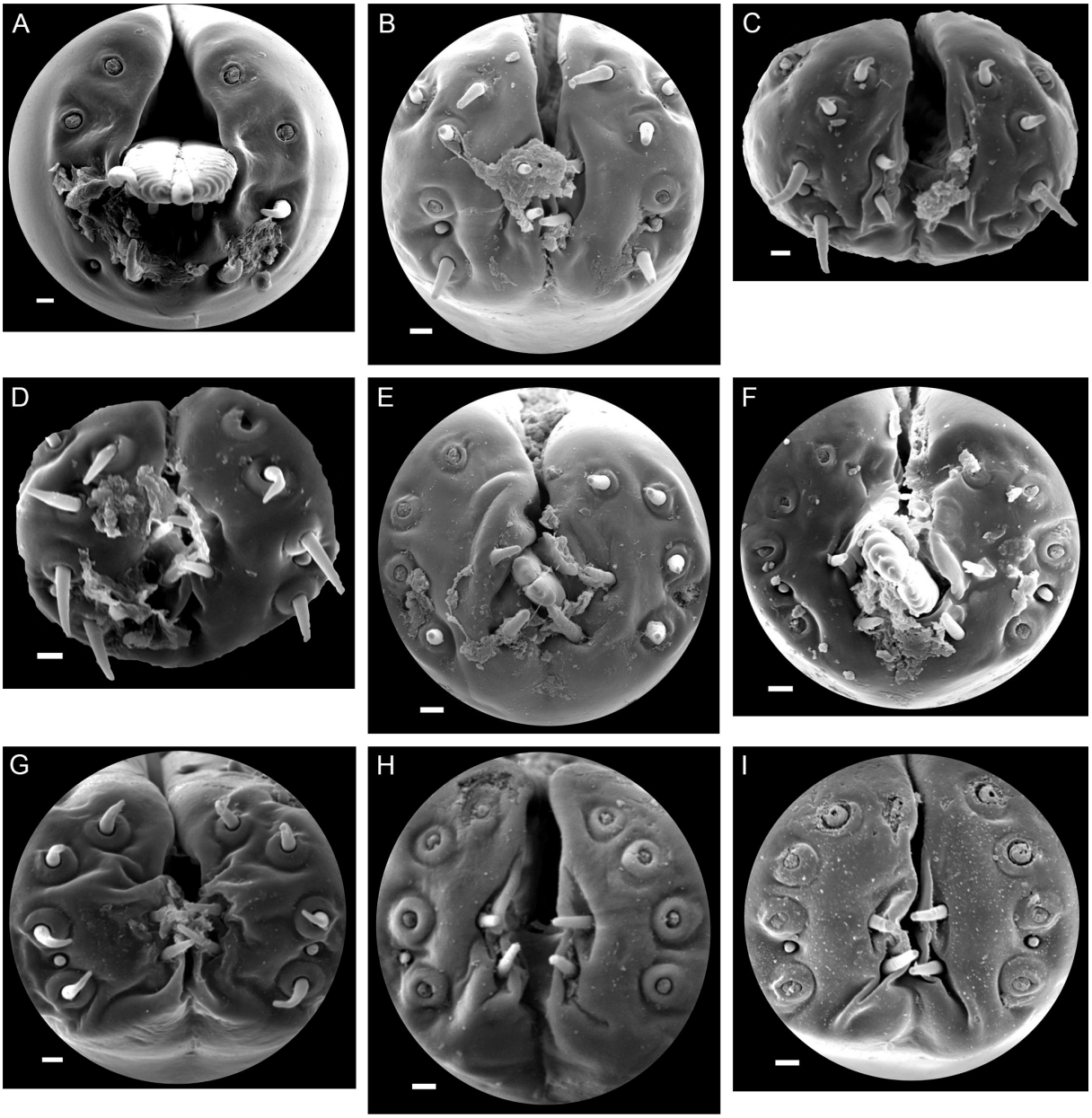
Supplement 3. Fig. 29: Labium tip in Peloridiidae, sutural view. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecus acutus*, E – *Hemiodoecus crassus*, F – *Hemiodoecus leai*, G – *Hemiodoecellus fidelis*, H – *Hemiowoodwardia wilsoni*, I – *Idophysa chonos*, J – *Pantinia darwini*, K – *Peloridium hammoniorum*, L – *Peloridium pomponorum*. Scale bars: 3 µm.



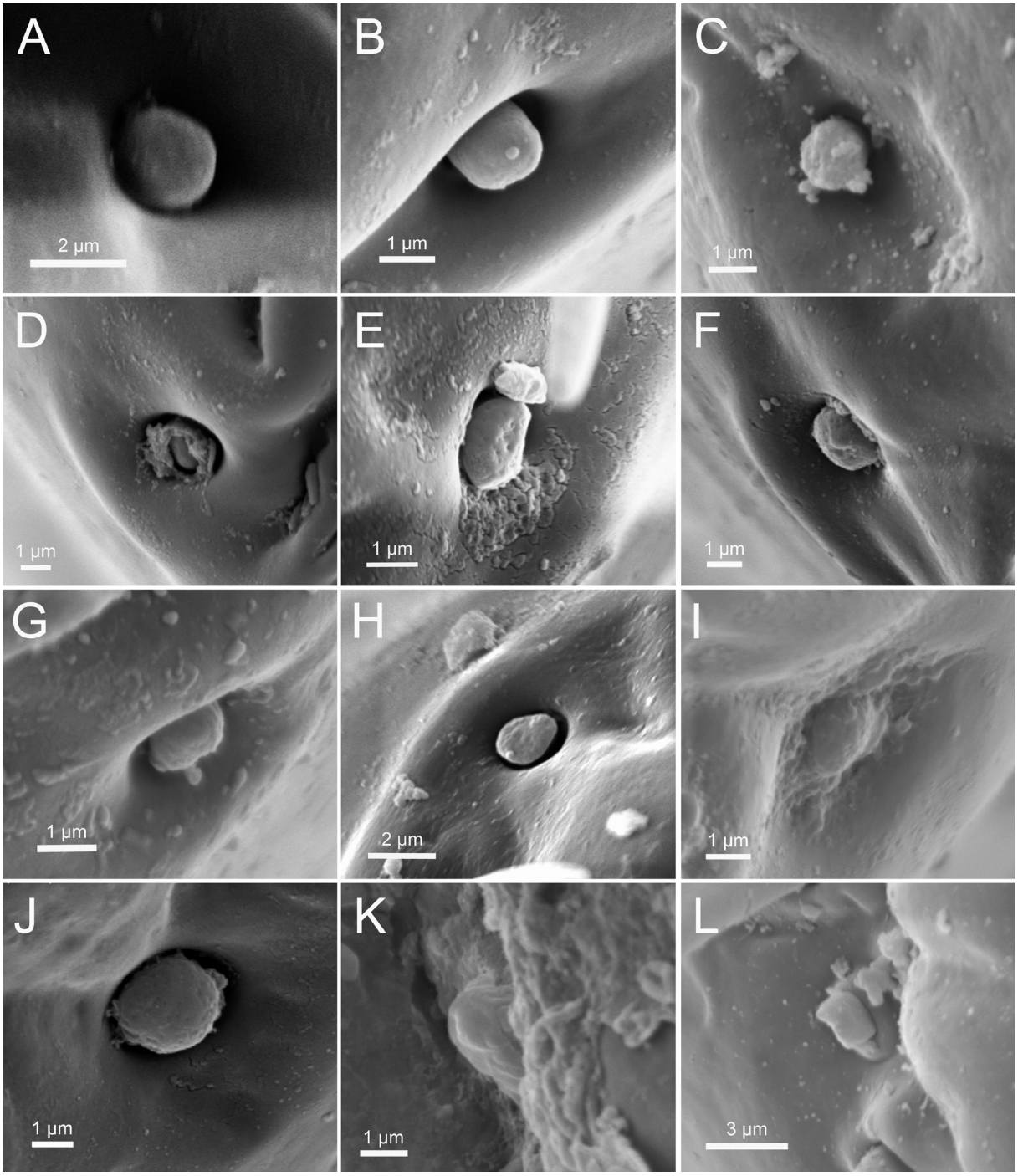
Supplement 3. Fig. 30: Labium tip in Peloridiidae, sutural view. A – *Peloridora holdgatei*, B – *Xenophysella greensladeae,* C – *Xenophysella stewartensis*, D – *Oiophysa ablusa*, E – *Oiophysa cumberi*, F – *Oiophysa distincta*, G – *Xenophyes cascus*, H – *Xenophyes kinlochensis*, I – *Xenophyes rhachilophus*. Scale bars: 3 µm.



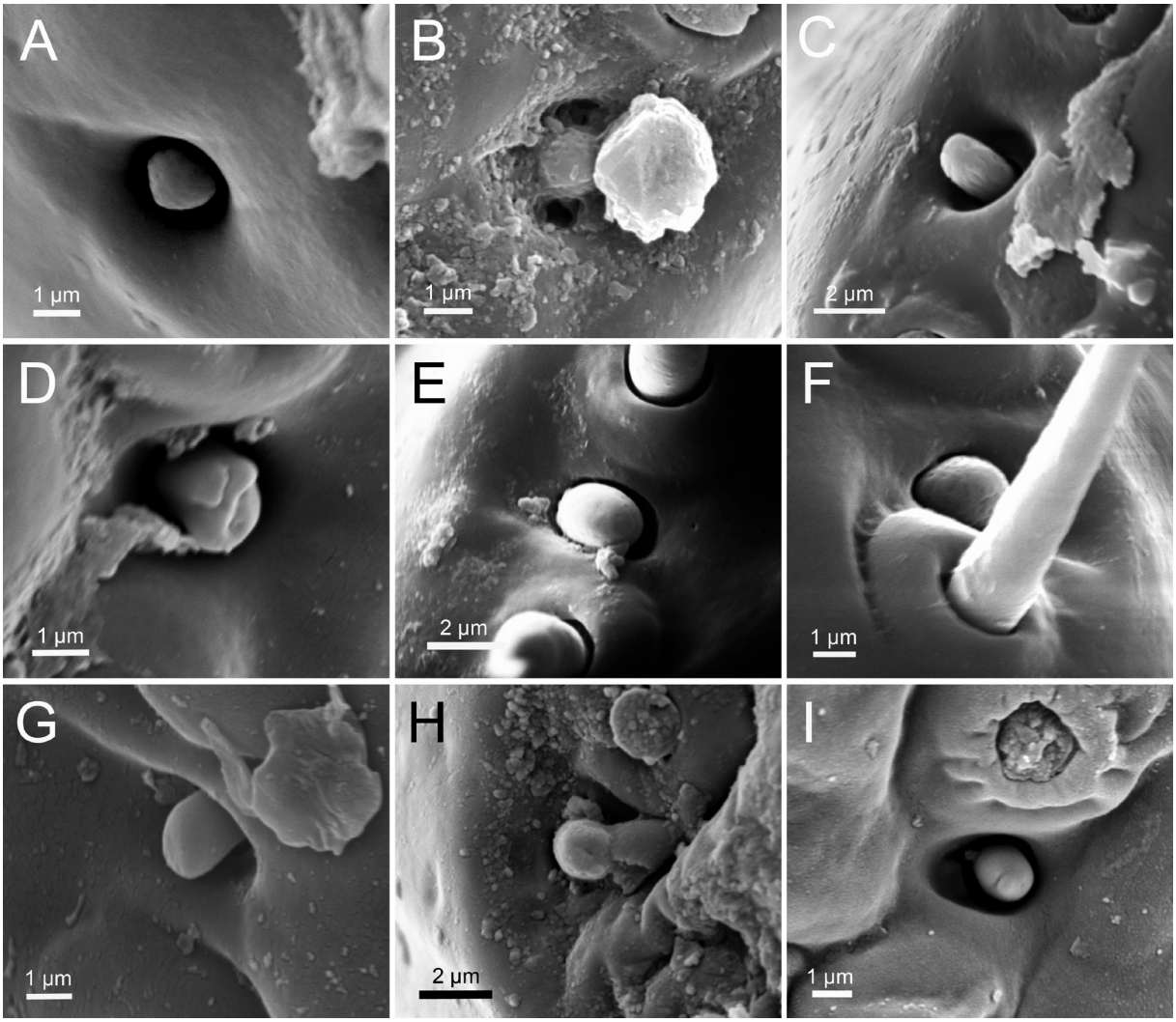
Supplement 3. Fig. 31: Labium tip in Peloridiidae, frontal view. A – *Hackeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecus acutus*, E – *Hemiodoecus crassus*, F – *Hemiodoecus leai*, G – *Hemiodoecellus fidelis*, H – *Hemiowoodwardia wilsoni*, I – *Idophysa chonos*, J – *Pantinia darwini*, K – *Peloridium hammoniorum*, L – *Peloridium pomponorum*. Scale bars: 3 µm.



Supplement 3. Fig. 32: Labium tip in Peloridiidae, frontal view. A – *Peloridora holdgatei*, B – *Oiophysa ablusa,* C – *Oiophysa cumberi*, D – *Oiophysa distincta*, E – *Xenophysella greensladeae*, F – *Xenophysella stewartensis*, G – *Xenophyes cascus*, H – *Xenophyes kinlochensis*, I – *Xenophyes rhachilophus*. Scale bars: 3 µm.



Supplement 3. Fig. 33: Coeloconic sensillum on labium tip in Peloridiidae. A – Ha*ckeriella brachycephala*, B – *Hackeriella echina*, C – *Hackeriella veitchi*, D – *Hemiodoecus acutus*, E – *Hemiodoecus crassus*, F – *Hemiodoecus leai*, G – *Hemiodoecellus fidelis*, H – *Hemiowoodwardia wilsoni*, I – *Idophysa chonos*, J – *Pantinia darwini*, K – *Peloridium hammoniorum*, L – *Peloridium pomponorum*.



Supplement 3. Fig. 34: Coeloconic sensillum on labium tip in Peloridiidae. A – *Peloridora holdgatei*, B – *Xenophysella greensladeae*, C – *Xenophysella stewartensis*, D – *Oiophysa ablusa*, E – *Oiophysa cumberi*, F – *Oiophysa distincta*, G – *Xenophyes cascus*, H – *Xenophyes kinlochensis*, I – *Xenophyes rhachilophus*.

12 Supplement 4. Specimens used for SEM and their character states

In this supplement, an overview is given of the specimens that were used for scanning electron microscopy and character states found in them. This information should make the decisions behind the coding of the character states in the matrix (Results, section 3.4.) more obvious and easier to follow. At the same time, the variability of the chacarters (if observed) is made explicit. Host plants and locations (cf. with Supplement 1.) of the specimens are given; specimens are referred to according to the provisional designation to a "CRH" with a number or "Tier" with a number; M indicates a male, F a female, R is right and L is left (when speaking of paired organs). Sometimes a specimen is referred to as originating from several host plants at once; such cases mean that the specimen was kept alive in the laboratory for a while, together with some other specimens; all the host plants from which the specimens were obtained are named, but it cannot be stated with certainty from which exact host plant a particular specimen originated. "n" that is given in brackets after many characters means the number of the specimens or structures in question (i.e. tarsi, antennae, glands etc.) that were analyzed. The respective SEM recordings are stored at the Berlin Museum of Natural History and author's private collection according to this nomenclature.

The characters used in the character matrix are given with their respective numbers. Some of the initially considered characters were not used in the final version of phylogenetic analysis but are nevertheless given after the numbered characters, since they often provided traits where ndividual or other patterns of variation could be observed.

Hackeriella brachycephala

Specimens analyzed
CRH017, M, 07.12.2009, Carpark, from unsifted *Dicranoloma dicarpum*
CRH136, M, 03.12.2009, Eagle's Nest track, from sifted *Dicranoloma dicarpum* (analyzed dorsally)
Tier 37, M, 03.12.2009, sifted leaf litter, Eagle's Nest track
(all from New England National Park, New South Wales, Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 3 specimens, 6 legs)
7. *Form T1*[107]: slightly tapered
26. *Microtrichia on membranous area*[108]: no (n = 1)
27. *Form of the flagellum (caudal view)*: ventral margin convex, with a constriction in the apical third defining the tip (n = 2 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow or row
29. *Scales on the flagellum petiolus*: slender, do not touch each other

[107] Here and elsewhere in this supplement, T1 denotes the first tarsal segment, T2 the second.
[108] Here and elsewhere: between the claw and the unguitractor.

30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (although in both specimens analyzed the flagellum is partly obscured by secretion; n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 3 specimens)
37. *Microtrichia medially on genal area absent/present*: absent (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 3 specimens). In the 5th larval instar the situation is exactly opposite – the middle regions bears microtrichia, whereas the periphery does not.
38. *Punctation on genal area present/absent*: absent (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 3 specimens)
39. *Microtrichia on genal area covered with wax/not*: not covered with wax (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 3 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 3 specimens)
41. *First abdominal tergite*: narrow and long (240 width /140 µm length (= 1,7); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: present on veins and membranous areas between them (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculptured on most part of its length (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 3)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: apical radial cell with a bare spot (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: reaches to the center of the cell (n = 3)
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)
59. *Ventral sculpture on tegmina scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: present (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins different to that on membranes (n = 3), membranes carrying scales and veins – "compressed scales"
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements mostly not differentiated into inner/outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (n = 3)
73. *Integumental glands, inner elements relative size.* n/a
74. *Integumental glands, outer elements*. Not clubbed (n = 3)
75. *Integumental glands, outer[109] elements on dif. body regions*. Peripheral elements number does not vary with body region (n = 3)

[109] Or simply peripheral elements, if those are not differentiated into an inner and outer circle, as in this species.

76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 3)
77. *Integumental glands, individual variation*. No individual variation found (n = 3)
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron*: n/a
80. *Integumental glands on abdominal terga, similarity*: n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH136 L: 4, CRH017 R: 3 (but secretion obscures some parts of the antenna), Tier 37 R: 4; all in a narrow row along the "ventral axis" (imaginary line between the shaft of the flagellum and its tip). Modal class: 4
Length/form of the placoid sensillum: ca. 0,4 of the flagellum length (n = 2 antennae, 1 specimen, but the partly visible antennae in other specimens comply with that too)
Number of coeloconic sensilla: CRH136 L = 9, Tier 37 = 8. Modal class: 8-9
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching far back): stretch back almost as far as the placoid sensillum, ca. 0,4 of the flagellum length (n = 2 antennae, 2 specimens)
Setae T1: 2-2[110], 2-3, 2-3, 3-3, 2-2, 3-3. Average = 2,5; variance = 0,27. No obvious correlation with population or host plant; only males studied.
Ventral rows of setae T2: CRH136: 4-4[111] (L), 5-6 (R); Tier 37: 4-4 (L), 4-5 (R); CRH017: 5-4 (L), 4-5 (R). Average = 4,5; variance = 0,45. The right foot has in all 3 specimens studied more or at least the same number of setae, although the sampling is too poor to state anything for sure. No obvious correlation with population or host plant; only males studied.
Scales on unguitractor: 3 scales in each row (n=3 legs, 2 specimens), except one case where one lateral row has 4 scales (CRH136, HR)
Integumental glands, inner elements number. n/a
Integumental glands, outer (or non-differentiated) elements average number[112]. CRH017_18 R Paranotum: 18x2, 11x3, 1x4[113]. CRH136 28 L Paranotum: 12x2, 6x3. Tier 37 26 Abdomemende: 2x2, 8x3. Average (rounded) = 2. (3 elements also occur often; one of the three is then distinctly smaller than the other two; sometimes two small elements and one large)
Integumental glands, longest outer element. 4-6 µm.
Integumental glands, density[114]. Tier 37 H brachycephala 40 R Tegmen außen, 20 µm scale: 44 glands

Notes: Sometimes the angles of the V-shaped channel opening of the gland become differentiated into small elements of an inner circle (in this case the opening becomes circular) – "Tier 37 H brachycephala 17 R Paranotum Stonehenge". V-shaped channel opening is well seen in "Tier 37 H brachycephala 27 Abdomenende Stonehenge".

[110] Here and elsewhere , this notation means that there are two setae on the rigth and two on the left side of the ventral surface of the first tarsal segment (T1); 2-3 that there are two on the left and three on the right side etc.
[111] Same notation principle as for the T1.
[112] Here and elsewhere, counted from SEM pictures named further: "CRH017_18 R Paranotum".
[113] Here and elsewhere , this notation means that there were 18 glands with two peripheral elements, 11 with three elements and one with 4 elements.
[114] Here and elsewhere, estimated from the SEM picture named immediately after; between the species, glands were counted on areas of similar size.

Larvae (8 specimens analyzed, 2nd to 5th instars, one specimen of each dorsally and one ventrally): the glands are small knobs (ca. 6-8 µm diameter) with a slit-like opening on one side, very close to the ground; the opening is invisible because covered by peripheral elements (2-4) of ca. 2 µm length.

Hackeriella echina

Specimens analyzed
CRH083, M, 19.11.2009, Wanungara Lookout, from *Wijkia extenuata* on *Nothofagus moorei*
CRH084, F, 19.11.2009, Wanungara Lookout, from *Wijkia extenuata* on *Nothofagus moorei*
(all specimens from Lamington National Park, Queensland, Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n=2 specimens, 3 legs)
26. *Microtrichia on membranous area*: no (n = 2 legs, 2 specimens)
27. *Form of the flagellum (caudal view)*: ventral margin convex, with constriction in apical third defining the tip (n = 2 antennae, 1 specimen)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow or single row
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 3 antennae, 2 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 2 antennae, 2 specimens), although the deeply folded surface structure reminds of scales
36. *The genal area under the antennae flat/concave in the middle*: concave (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 2 specimens)
37. *Microtrichia medially on genal area absent/present*: absent (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 2 specimens).
38. *Punctation on genal area present/absent*: absent (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 2 specimens)
39. *Microtrichia on genal area covered with wax/not*: not covered with wax (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 2 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 1 with antenna removed + 3 partly visible regions with intact antennae in 2 specimens)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 2)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: present on veins and membranous areas between them (n = 2)
51. *Ventral sculpture on tegmina, ScP*: sculptured on most part of its length (n = 2)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 2)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 2)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 2)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 2)
56. *Ventral sculpture on tegmina, apical radial cell*: apical radial cell with a bare spot (n = 2)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: reaches to the center of the cell (n = 2)
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 2)
59. *Ventral sculpture on tegmina, scales*: present (n = 2)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 2)

62. *Ventral sculpture on tegmina, "compressed scales"*: present (n = 2)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins different to that on membranes (n = 2), membranes carrying scales and veins "compressed scales"
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 2)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 2)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 2)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements not differentiated (n = 2)
72. *Integumental glands, orifice*. Not sunk-in (n = 2).
73. *Integumental glands, inner elements relative size*. n/a
74. *Integumental glands, outer elements*. Not clubbed (n = 2)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 2)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different from those on other body regions (n = 2)
77. *Integumental glands, individual variation*. No individual variation found (n = 2)
78. *Integumental glands on abdominal terga*. n/a (specimens were not studied dorsally)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH083 R = 5 (not in a narrow row), CRH083 L = 3 (in a row, but the antenna is not well visible), CRH084 R = 4 (in a row). Median: 4
Length/form of the placoid sensillum: ca. 0,25 of the flagellum length (n = 2 antennae, 1 specimen)
Number of coeloconic sensilla: CRH083 R = 9, CRH083 L = 8, CRH084 R = 8. Modal class: 8.
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch even further back than the placoid sensillum, ca. 0,32 of the flagellum length (n = 3 antennae, 2 specimens)
Setae T1: CRH083 3-3 (R), 3-2 (L), CRH084 3-3 (R). Average = 2,83; variance = 0,17.
Ventral rows of setae T2: CRH083 4-4 (R), 4-4 (L), CRH084 3-5 (R). Average = 4; variance = 0,4.
Form T1: slightly tapered (n = 2 specimens, 3 legs)
Scales on unguitractor: 3-4-3 scales (from left to right), n = 2 legs, 2 specimens (3-4-3 in on one foreleg, 4-4-3 in another)
Integumental glands, inner elements number. n/a
Integumental glands, outer (or non-differentiated) elements average number. CRH083 24 R Paranotum: 1x2, 15x3, 6x4. CRH083 28 Abdomen: 2x2, 7x3, 3x4. CRG084 31 L Paranotum: 3x2, 5x3. Average = 3.
Integumental glands, longest outer element. 5-6 µm (n = 2)
Integumental glands, density. CRH083 H echina 46: 42 glands

Notes: 1 or 2 of the peripheral gland elements clearly longer (3-4 µm) than the others (under 2 µm). (In this species the transitional condition between slit-shaped gland opening without inner elements and small peg-like inner elements can be seen).
All dorsal characters not applied to this species, since no specimens were analyzed dorsally.

Hackeriella veitchi

Specimens analyzed

Tier 1, M, 11.11.09, Lamington National Park, Mt Hobwee, from *Dicranoloma dicarpum* on *Nothofagus moorei*
Tier 7, M, summer 2007, Springbrook National Park, from unspecified bryophytes
Tier 24, M, summer 2006, Springbrook National Park, from unspecified bryophytes
Tier 25, F, summer 2007, Springbrook National Park, from unspecified bryophytes
Tier 26, M, summer 2006, Springbrook National Park, from unspecified bryophytes
Tier 29, M, summer 2007, Springbrook National Park, from unspecified bryophytes
Tier 30, F, summer 2007, Springbrook National Park, from unspecified bryophytes
Tier 40, M, summer 2007, Springbrook National Park, from unspecified bryophytes
Tier 45, M, summer 2006, Springbrook National Park, from unspecified bryophytes (analyzed dorsally)
(all specimens from Queensland, Australia)

Characters

1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 9 specimens, 13 legs)
7. *Form T1*: quite apparently tapered (n = 6 specimens, 8 legs)
26. *Microtrichia on membranous area*: no (n=4)
27. *Form of the flagellum (caudal view)*: ventral margin convex, with constriction in apical third defining the tip (n = 7 antennae, 7 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no row/furrow
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 8 antennae, 6 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: not reaching apical third (n = 8 antennae, 7 specimens), although in Tier 7 the deeply folded surface reminds of scales (as in *H. echina*)
36. *The genal area under the antennae flat/concave in the middle*: concave (5 parts of 5 specimens with antennae removed, supported by 11 measurements in 9 specimens where the region is only partly visible due to intact antennae or secretion cover)
37. *Microtrichia medially on genal area absent/present*: absent (5 parts of 5 specimens with antennae removed, supported by 11 measurements in 9 specimens where the region is only partly visible due to intact antennae or secretion cover)
38. *Punctation on genal area present/absent*: absent (5 parts of 5 specimens with antennae removed, supported by 11 measurements in 9 specimens where the region is only partly visible due to intact antennae or secretion cover)
39. *Microtrichia on genal area covered with wax/not*: not covered with wax (5 parts of 5 specimens with antennae removed, supported by 11 measurements in 9 specimens where the region is only partly visible due to intact antennae or secretion cover)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (18 in 9 specimens)
41. *First abdominal tergite*: n/a
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 6)

50. *Ventral sculpture on tegmina, presence veins vs. membranes*: present on veins and membranous areas between them (n = 6)
51. *Ventral sculpture on tegmina, ScP*: sculptured on most part of its length (n = 5)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 6)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 6)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 5), although the bare area is clearly smaller than in other *Hackeriella* species and at least one specimen (Tier 29) bears scales on M + CuA
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 6)
56. *Ventral sculpture on tegmina, apical radial cell*: apical radial cell with a bare spot (n = 4); in one case (Tier 25) the bald spot is unusually small; this probably does not have anything to do with sex or population (all specimens analyzed are from the same population and another female, Tier 30, has a large bare spot). In Tier 29 the region in question is damaged and cannot be assessed
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: reaches to the center of the cell (n = 4); but note the very small spot in Tier 25
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 5)
59. *Ventral sculpture on tegmina scales*: present (n = 6)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 6)
62. *Ventral sculpture on tegmina, "compressed scales"*: present (n = 6)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins different to that on membranes (n = 6), membranes carrying scales and veins – "compressed scales"
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 7)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 7)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 7)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements not differentiated into inner/outer circle (n = 8)
72. *Integumental glands, orifice*. Not sunk-in (n = 8)
73. *Integumental glands, inner elements relative size*. n/a
74. *Integumental glands, outer elements*. Not clubbed (n = 8)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 8)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 8)
77. *Integumental glands, individual variation*. No individual variation found (n = 8).
78. *Integumental glands on abdominal terga*. Glands absent from abdominal terga (n = 1)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:
Number/position of setae on the ventral surface of the flagellum: Tier 1 L = 4 (not in a row, specimen overtreated with KOH) R = 2 (in one row, specimen overtreated with KOH), Tier 7 L = 5 (in one row) R = 4 (not in one row), Tier 24 R = 2 (specimen quite dirty), Tier 25 L = 3 (in a row, specimen dirty), Tier 26 L = 5 (in a row), Tier 29 R = 5 (not in a row), Tier 30 R = 4 (not in a row, the terminal seta is not visible but postulated as present since it is present in all Peloridiidae and this specimen is probably just too dirty), Tier 40 L = 4 (in a row, specimens quite dirty). Modal class: 4
Length/form of the placoid sensillum: ca. 0,3 of the flagellum length (n = 3 antennae, 2 specimens)

Number of coeloconic sensilla: Tier 24 R = 7 (specimen dirty), Tier 25 L = 8, Tier 29 R = 8 (specimen dirty), Tier 30 R = 8 (specimen dirty), Tier 40 R = 7, L = 8, Tier 45 R = 8. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back as long as the placoid sensillum, ca. 0,3 of the flagellum length (n = 8 antennae, 6 specimens)
Setae T1: Tier 26: 3-3 (L), 3-3 (R); Tier 40: 2-2 (R), 3-3 (L); Tier 45: 3-2 (L); Tier 7: 2-2 (L); Tier 29: 2-3 (R); Tier 30: 2-3 (R), 2-3 (L). Average = 2,56; variance = 0,26. No correlation with sex, all animals but one are from the same population, host plants unknown. No differences between the right and left legs.
Ventral rows of setae T2: Tier 24: 4-4 (L); Tier 26: 3-3 (L), 4-5 (R); Tier 40: 5-4 (R), 5-4 (L); Tier 45: 5-3 (L); Tier 7: 4-3 (L); Tier 30: 4-4 (R), 5-4 (L). Average = 4,06; variance = 0,53. No obvious correlation with sex, all animals but one are from the same population, host plants unknown. Here no differences between the right and left legs.
Scales on unguitractor: Tier 26: 3-3-3 (R); Tier 45: 3-3-3 (L); Tier 7: 3-4-3 (L); Tier 30: 3-3-3 (R)
Integumental glands, inner elements number. n/a
Integumental glands, outer (or non-differentiated) elements average number. Tier 25 H veitchi R Paranotum 20: 3x2, 14x3, 1x4. Tier 45 H veitchi 05 L Kopfseite: 3x2, 6x3, 3x4. Tier 7 Abdomen 26: 3x2, 14x3, 6x4. Average = 3
Integumental glands, longest outer element. 4-5 µm (n = 8)
Integumental glands, density. Tier 26 H veitchi 46 R Tegmen außen: 52.

Notes: integumental glands with up to 6 peripheral elements, mostly 3 (one of the three is often distinctly smaller than the other two; sometimes two small elements and one large).

Hemiodoecellus fidelis

Specimens analyzed
CRH020, M, February 2010, Russell Falls, from *Leucobryum candidum*
Tier 11, M, February 2010, Russell Falls, from *Leucobryum candidum*
Tier 38, M, February 2010, Russell Falls, from *Leucobryum candidum*
Tier 47, M, February 2010, Russell Falls, from *Leucobryum candidum* (analyzed dorsally)
(all specimens from Mount Field National Park, Tasmania, Australia)

Characters

1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 1 spur on the inner side, 1 ventrally (n= 4 specimens, 7 legs)
7. *Form T1*: quite apparently tapered (n=6)
26. *Microtrichia on membranous area*: no (n=1 and it could be damaged by KOH, but no m-trichia can be seen) – but there are some on ML of CRH020
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 5 antennae, 3 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, no single row (n = 3 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: not well visible in all available specimens
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching its apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (a slight concavity is present, although it is not so pronounced as in *Hackeriella* species) (n = 2 parts of 1 specimen with antennae

removed, supported by 2 measurements in 2 specimens where the region is only partly visible due to intact antennae or secretion cover)
37. *Microtrichia medially on genal area absent/present*: present (n = 2 parts of 1 specimen with antennae removed, supported by 2 measurements in 2 specimens where the region is only partly visible due to intact antennae; all specimens are at least partly covered by secretion)
38. *Punctation on genal area present/absent*: absent (n = 2 parts of 1 specimen with antennae removed, supported by 1 measurements where the region is only partly visible due to intact antennae and secretion cover)
39. *Microtrichia on genal area covered with wax/not*: not covered with wax (n = 2 parts of 1 specimen with antennae removed, supported by 2 measurements in 2 specimens where the region is only partly visible due to intact antennae or secretion cover)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 2 parts of 1 specimen with antennae removed, supported by 2 measurements in 2 specimens where the region is only partly visible due to intact antennae)
41. *First abdominal tergite*: narrow and long (240 width / 140 µm length (= 1,7); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: present mostly only on veins, only laterally of R are membranous parts covered with scales as well (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 3)
53. *Ventral sculpture on tegmina, clavus*: n/a
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: n/a
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)
59. *Ventral sculpture on tegmina scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on membranes, where present, is the same as on veins (n = 3), both membranes and veins carrying only scales
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements not differentiated into inner/outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (n = 3)
73. *Integumental glands, inner elements relative size*. n/a
74. *Integumental glands, outer elements*. Not clubbed (n = 3)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 3)
76. *Integumental glands on head and pronotum*. Glands on dorsal surface of the head and thorax are set on elevations of cuticula (n = 1)
77. *Integumental glands, individual variation*. No individual variation found (n = 3).

78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron.* n/a
80. *Integumental glands on abdominal terga, similarity.* n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH020 R and Tier 38 R – in both cases the specimens are too dirty, only the top seta is visible.
Length/form of the placoid sensillum: ca. 0,3 of the flagellum length (n = 1)
Number of coeloconic sensilla: CRH020 R = 7 (specimen partly obscured by secretion), Tier 38 R = 8, L = 8. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch as far or almost as far back as the placoid sensillum, ca. 0,3 of the flagellum length (n = 2 antennae, 1 specimen)
Setae T1: CRH020: 2-2 (R), 2-2 (L); Tier 38: 2-2 (L), 2-2 (R); Tier 47: 2-2 (L), 2-2 (R); Tier 11: 2-3 (L). Average = 2,07; variance = 0,07. No differences between left and right.
Ventral rows of setae T2: CRH020: 3-4 (R), 3-4 (L); Tier 38: 4-3 (L), 4-4 (R); Tier 47: 3-3 (L); Tier 11: 4-4 (L). Average = 3,58; variance = 0,27. No differences between left and right.
Scales on unguitractor: 3-3-3 (n = 1)
Integumental glands, inner elements number. n/a
Integumental glands, outer (or non-differentiated) elements average number. CRH020_38 R Tegmen außen: 2x3, 2x4, 1x5. Tier 38_37, R Kopfseite: 2x4, 4x5. Tier 47_04 Kopf dorsal: 1x2, 3x3, 8x4, 3x5, 2x6. Tier 47_10 Paranotum dorsal 1x3, 7x4, 2x5, 2x6, 1x7. Average: 4
Integumental glands, longest outer element. 2-3 µm (n = 3)
Integumental glands, density. Tier 38 H fidelis 48 R Tegmen außen: 33 glands.

Notes: Glands on the dorsal surface of the head are different from those on the rest of the body, not surrounding a depression in the cuticle where the gland channel opens, but standing on a small round elevation of the cuticula (similar to the condition in larvae).

Hemiodoecus acutus

Specimens analyzed
CRH042, M, 18.01.2010, Triplet falls, from *Schistochila lehmanniana*
CRH145, F, 18.01.2010, Triplet falls, from *Schistochila lehmanniana* (analyzed dorsally)
Tier 43, F, January 2010
(all specimens from Great Otways National Park, Victoria, Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 3 specimens, 4 legs)
7. *Form T1*: slightly tapered (n = 1 specimen, 2 legs)
26. *Microtrichia on membranous area*: no (n = 1)
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 4 antennae, 2 specimens)

28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: not one row, no furrow (n = 4 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: in Tier 43 L broad and almost touch each other, in CRH042 distinctly more slender and do not touch each other
30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: not reaching apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: appears concave in 3 cases (2 specimens) where it is only partly seen due to intact antennae and/or secretion cover.
37. *Microtrichia medially on genal area absent/present*: in all available 3 cases (2 specimens) hard to decide due to intact antennae and/or secretion cover (more like the middle region bears microtrichia, but hard to be sure).
38. *Punctation on genal area present/absent*: absent (3 cases, 2 specimens), but in all specimens the region is only partly seen due to intact antennae and/or secretion cover.
39. *Microtrichia on genal area covered with wax/not*: not covered with wax (3 cases, 2 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (3 cases, 2 specimens) where it is only partly seen due to intact antennae and/or dirt covering.
41. *First abdominal tergite*: n/a
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 μm) (n = 1)
44. *Microtrichia arrangements*: single, in groups of 5-7 that are arranged in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: grouped, but not arranged in circles (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 2)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture abundant on veins as well as on membranes (n = 2)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent on mpost of the veins length (n = 2)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 2)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 2)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 2)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 2)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is present on the posterior margin (n = 2)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: only marginal, not reaching into center (n = 2)
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 2)
59. *Ventral sculpture on tegmina, scales*: present (n = 2)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 2)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 2)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on membranes, where present, is the same as on veins (n = 2), both membranes and veins carrying only scales
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 4)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 4)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 4)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements not differentiated into inner/outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (n = 3)
73. *Integumental glands, inner elements relative size*. n/a
74. *Integumental glands, outer elements*: clubbed (n = 3)

75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 3)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 3)
77. *Integumental glands, individual variation*: no individual variation found (n = 3)
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: Tier 43 L = 3 (in one row), R = 3 (not possible to say if it is a single row). Modal class: 3
Length/form of the placoid sensillum: ca. 0,3 of the flagellum length (n = 4 antennae, 2 specimens)
Number of coeloconic sensilla: CRH042 R = 7, CRH042 L = 7; Tier 43 R =6, L = 7. Modal class: 7
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back as far or almost as far back as the placoid sensillum, ca. 0,3 of the flagellum length (n = 4 antennae, 2 specimens)
Setae T1: CRH042: 2-2 (L), 2-2 (R); CRH145: 2-2 (L). Average = 2; variance = 0.
Ventral rows of setae T2: CRH042: 4-3 (L), 4-4 (R); CRH145: 3-4 (L). Average = 3,7; variance = 0,3.
Scales on unguitractor: only in once case partly seen: 3 scale in the middle row and 3 in one of the lateral.
Integumental glands, inner elements number: n/a
Integumental glands, outer (or non-differentiated) elements average number: CRH042 H acutus 22 R Paranotum: 1x1, 11x2, 4x3, 1x4. CRH145 H acutus 19 Kopf: 4x1, 19x2, 1x3. Tier 43 H acutus 44 L Tegmen außen: 9x2, 1x3. Average = 2.
Integumental glands, longest outer element: 8-12 µm (n = 3)
Integumental glands, density: CRH042_H acutus 44 R Tegmen außen: 70 glands

Notes: initially this species was considered as having differentiated inner and outer elements in integumental glands, but after comparing it to *Hackeriella* on one side (no differentiation) and *Pantinia* on another (clear differentiation) my opinion was changed – it is much closer to the condition in *Hackeriella* where the glandular opening sometimes has corners that remind of elements.

Hemiodoecus crassus

Specimens analyzed
CRH080, M, 26.12.09, Sawyer's Hill, from *Sphagnum cristatum*
CRH082 M, 26.12.09, Sawyer's Hill, from *Sphagnum cristatum* (analyzed dorsally)
Tier 5, F, 26.12.09, Sawyer's Hill, from *Sphagnum cristatum*
(all specimens from Kosciuszko National Park, New South Wales, Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n= 2 specimens, 2 legs)
7. *Form T1*: quite clearly tapered in one specimen and only slightly so if at all in another

26. *Microtrichia on membranous area*: no (n = 2 legs of the same specimen that could be distorted by KOH)
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 1 antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 2 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 1 antenna)
30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: not reaching beyond apical third (n = 1)
36. *The genal area under the antennae flat/concave in the middle*: concave in 2 cases (1 specimen)
37. *Microtrichia medially on genal area absent/present*: absent in 2 cases (1 specimen)
38. *Punctation on genal area present/absent*: absent in 2 cases (1 specimen)
39. *Microtrichia on genal area covered with wax/not*: no wax in 2 cases (1 specimen)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex in 2 cases (1 specimen)
41. *First abdominal tergite*: narrow and long (260 µm width / 150 µm length (= 1,7); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 2)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture abundant on veins as well as on membranes (n = 2)
51. Ventral sculpture on tegmina, ScP: sculpture absent (n = 2)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 2)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 2)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 2); the bare spot that in most other species only partly occupies the vein M + CuA is very broad in both analyzed specimens of this species and continues, with a small interruption at the spot where M and CuA part, till the medial margin of the tegmen (s. Supplement 2, fig. 19F)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 2)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 2)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 2)
59. *Ventral sculpture on tegmina, scales*: present (n = 2)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 2)
62. *Ventral sculpture on tegmina, "compressed scales"*: present (n = 2)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on membranes is different from that on veins (n = 2); membranes carry broad scales, whereas veins – shorter or "deformed" scales
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 2)
72. *Integumental glands, orifice*. Not sunk-in (n = 2)
73. *Integumental glands, inner elements relative size*: inner elements much smaller than the outer elements (n = 2)

74. *Integumental glands, outer elements*. Clubbed (n = 2)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number varies wit body region. Glands on head and pronotum tend to have more outer elements than the glands on tegmina, 3 vs. 2 in average (Tegmina: CRH080 H crassus 55 L Tegmen außen: 5x2, 0x3. CRH082 H crassus 30 L Tegmen außen: 13x2, 2x3. Average: 2. Paranota/head: CRH082 H crassus 14 R Paranotum: 7x2, 12x3, 4x4. CRH080 H crassus 14 R Paranotum: 13x2, 22x3. Average: 3)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 2)
77. *Integumental glands, individual variation*. No individual variation found (e.g. average numbers of outer elements in the two studied individuals compared). (n = 2)
78. *Integumental glands on abdominal terga.* Absent (n = 1)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: Tier 5 = 1 (only the terminal one can be seen, the specimen is in poor condition due to KOH overtreatment and contamination); CRH082 R = 3 (but the region is only partly seen). Modal class: 3
Length/form of the placoid sensillum: ca. 0,25 of the flagellum length; shorter than in *Hackeriella* or *H. acutus* along the dorsal margin (n = 1 antenna)
Number of coeloconic sensilla: CRH082 R = 7, CRH080 R = 5 (the region is only partly visible here). Modal class: 7
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back as far as the placoid sensillum, ca. 0,25 of the flagellum length (n = 2 antennae, 2 specimens)
Setae T1: 2-2 in all 3 specimens tested (n = 3 legs). Average = 2; variance = 0.
Ventral rows of setae T2: CRH080: 3-3 (L); CRH082: 3-3 (L); Tier 5: 4-3 (R), 4-4 (L). Average = 3,38; variance = 0,27.
Scales on unguitractor: 3-3-3 (n = 2 legs of the same specimen)
Integumental glands, inner elements number. Average number of inner elements: 5 (determined from several pictures; the exact number is not always clear, since the elements may have projections that could be counted as separate elements in pictures with poorer magnification)
Integumental glands, outer (or non-differentiated) elements average number. 3 (average numbers vary between tegmina and rest of the body) (n = 2)
Integumental glands, longest outer element. 8-10 µm (n = 2)
Integumental glands, density. CRH082 H crassus 29: 99 glands

Note: as in *H. acutus*, the clubbed tips of outer elements easily break off.

Hemiodoecus leai

Specimens analyzed
CRH018, M, 22.12.2009, Kosciuszko National Park, Rennix Gap, from *Sphagnum cristatum*
CRH041, M, 06.01.2010, Mt. Donna Buang National Park, Acheron Gap, leaf litter

CRH140, M, 18.12.2009, Kosciuszko National Park, Rennix Gap, from *Sphagnum cristatum* (analyzed dorsally)
Tier 3, M, Kosciuszko National Park, Rennix Gap, from *Sphagnum cristatum*
Tier 36, M, Kosciuszko National Park, Rennix Gap, from *Sphagnum cristatum*
(all specimens from New South Wales (Kosciuszko NP) or Victoria (Mt. Donna Buang NP), Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 5 specimens, 7 legs)
7. *Form T1*: tapered (n = 7)
26. *Microtrichia on membranous area*: no (n = 1)
27. *Form of the flagellum (caudal view)*: ventral margin convex, without constriction defining the tip (n = 1 antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: not one row, no furrow (n = 4 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 2 antennae, 2 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: not reaching beyond apical third (n = 3 antennae, 3 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave in the middle in CRH018 R (antenna removed) and Tier 36 L (antenna intact), but more flat in CRH041 (R with antenna remioved, L with antenna intact)
37. *Microtrichia medially on genal area absent/present*: present (n = 2 cases in 2 specimens with antenna removed and 2 cases in 2 specimens with antennae intact)
38. *Punctation on genal area present/absent*: absent (n = 2 cases in 2 specimens with antenna removed and 2 cases in 2 specimens with antennae intact)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 2 cases in 2 specimens with antenna removed and 2 cases in 2 specimens with antennae intact)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 2 cases in 2 specimens with antenna removed and 2 cases in 2 specimens with antennae intact)
41. *First abdominal tergite*: narrow and long (290 µm width / 180 µm length (= 1,6); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, of more or less same size, in groups of 5-10 that are arranged in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: tend to be arranged in circles (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 5)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture abundant on veins as well as on membranes (n = 5)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 4)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 5)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 5)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 5)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 5)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is present in some specimens (Tier 3, CRH041) and absent or almost indiscernible in others (CRH018, CRH141, Tier 36). Since all studied specimens are males and all (except CRH041) are from the same population and host plant, this must be individual variation
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: if present, marginal (n = 2)
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)

59. *Ventral sculpture on tegmina, scales*: present (n = 5)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 5)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 5); some scales may be shorter than others, but never assume the form as in fig. 21c
64. *Ventral sculpture on tegmina, character veins vs. membranes*: the scales on the membranes may sometimes be somewhat broader than on veins, but mostly the sculpture on membranes and veins is the same (n = 5)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 4)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 4)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 4)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 4)
72. *Integumental glands, orifice*. Not sunk-in (n = 4)
73. *Integumental glands, inner elements relative size*. Inner elements much smaller than the outer elements (n = 4)
74. *Integumental glands, outer elements*. Clubbed (n = 4)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 4)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 4)
77. *Integumental glands, individual variation*. Individual variation present. "Tier 36"and CRH140 have an average of 2 elements in the outer circle (Tier 36 H leai 24 R Paranotum: 8x2, 3x3, 1x4. Tier 36 H leai 25 R Paranotum: 9x2, 1x3. Tier 36 H leai 30 Abdomenende: 12x2, 2x3, 2x4. Tier 36 H leai 38 L Kopfseite: 4x2, 1x3. CRH140_18 Pronotum zentral: 11x2, 3x3. CRH140_08 L Paranotum: 12x2, 4x3), whereas CRH018 and CRH041 have 3 (CRH18_13 Kopf: 6x2, 7x3. CRH041_19 R Paranotum: 5x2, 9x3). The differences seem to be independent of sex, host plant or population.
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
93. *Labium tip, coeloconic sensillum*: coeloconic, multiporous (CRH041 – relief of a larger pore?)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH041 L = 3 (one row), CRH140 L = 3 (but the region is not well visible), Tier 3 L = 3 (one row), Tier 36 L = 2 (partly obscured by dirt). Modal class: 3
Length/form of the placoid sensillum: ca. 0,25 of the flagellum length, broad on the tip and still broader and shorter than in *Hackeriella* or *H. acutus* along the dorsal margin (n = 2 antennae, 2 specimens)
Number of coeloconic sensilla: CRH041 L = 8; CRH140 L = 8; Tier 36 L = 8, R = 8. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back as far or almost as far as the placoid sensillum, ca. 0,25 of the flagellum length (n = 3)
Setae T1: 2-2 (n= 5 specimens, 7 legs). Average = 2; variance = 0.
Ventral rows of setae T2: Tier 3: 4-4 (R), 4-3 (L); CRH018: 4-4 (R), CRH041: 4-3 (L), CRH140: 4-4 (R); Tier 36: 3-4 (R), 4-4 (L). Average = 3,8; variance = 0,2. All specimens are male, no correlation to population visible, all except CRH041 (leaf litter) obtained from *Sphagnum cristatum*. No obvious left-right asymmetry.
Scales on unguitractor: 3-3-3 (n = 1; same on two forelegs of two different specimens)

Integumental glands, inner elements number: Average number of inner elements: 5 (determined from several pictures; the exact number is not always clear, since the elements may have projections that could be counted as separate elements in pictures with poorer magnification)
Integumental glands, outer (or non-differentiated) elements average number: 2 (average numbers vary between individuals)
Integumental glands, longest outer element: 6-10 µm (n = 4)
Integumental glands, density. Tier 36 H leai 43 R Tegmen außen: 80 glands

Hemiowoodwardia wilsoni

Specimens analyzed
CRH019, M, January 2010, Mait's Rest, from *Wijkia extenuata*, *Leucobryum candidum* and leaf litter
CRH077, M, 14.01.2010, Beauchamp falls, from *Wijkia extenuata* and *Rosulabryum subtomentosum* (analyzed dorsally)
CRH078, M, January 2010, Mait's Rest, from *Wijkia extenuata*, *Leucobryum candidum* and leaf litter (analyzed dorsally)
Tier 13, F, January 2010, Great Otways National Park
Tier 42, M, January 2010, Great Otways National Park
(all specimens from Great Otways NP, Victoria, Australia)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (CRH019 R; CRH078, both legs); 3, the ventral one absent (CRH077, both legs); 3, inner one absent (Tier 42); 2, ventral and inner ones absent (Tier 13, both legs – in this specimen artifacts are possible, since it was somewhat over-treated with KOH). CRH077 is from Beauchamp falls, whereas CRH019 and 078 are from Mait's rest; origin of Tier 13 and 42 unknown.
7. *Form T1*: Tapered (n = 5)
26. *Microtrichia on membranous area*: no (n = 2), same in 3 available fore and middle legs
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 2 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, no single row (n = 5 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: slender, do not touch each other (n = 3 antennae, 3 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave in the middle in 3 cases (3 specimens) with antennae removed and in 2 with antenna intact.
37. *Microtrichia medially on genal area absent/present*: absent in 3 cases (3 specimens) with antennae removed and 1 with antenna intact.
38. *Punctation on genal area present/absent*: absent in 3 cases (3 specimens) with antennae removed (in two cases not the whole region is visible due to contamination) and 1 with antenna intact
39. *Microtrichia on genal area covered with wax/not*: no wax in 3 cases (3 specimens) with antennae removed (in two cases the region is only partly visible due to contamination) and 1 with antenna intact.
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex in 3 cases (3 specimens) with antennae removed and 2 with antenna intact.

41. *First abdominal tergite*: narrow and long (290 µm width / 140 µm length (= 2,1); n = 1; the regions is damaged in CRH077)
42. *Plastron*: absent on narrow stripes on lateral regions of posterior segment borders (n = 2)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 2)
44. *Microtrichia arrangements*: single, of variable size, not grouped or arranged in rows (n = 2)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 2)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture abundant on veins as well as on membranes (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 5)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 3)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is present (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: marginal, close to ScP (n = 3)
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: present (n = 3); pegs sporadically occurred in other Australian species in the present study, but their frequency in *H. wilsoni* is clearly higher and does not appear sporadical
62. *Ventral sculpture on tegmina, "compressed scales"*: present (n = 5), although quite rare
64. *Ventral sculpture on tegmina, character veins vs. membranes*: the scales on veins are mostly shorter, sometimes becoming just pegs or "compressed scales"; membranes are covered with normal scales (n = 5)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 4)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 4)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 4)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 5)
72. *Integumental glands, orifice*. Not sunk-in (n = 5)
73. *Integumental glands, inner elements relative size.* Inner elements much smaller than the outer elements (n = 5)
74. *Integumental glands, outer elements*. Clubbed (n = 5)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 5)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 5)
77. *Integumental glands, individual variation*. No individual variation found (n = 5)
78. *Integumental glands on abdominal terga*. Glands absent from abdominal terga (n = 2)
79. *Integumental glands, under plastron*. n/a
80. *Integumental glands on abdominal terga, similarity* n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, most likely multiporous (not well visible), in CRH077 probably flattened

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH019 R = 1 (only small part of antenna covered by dirt), CRH077 R detached = 1 (the region is not wholly visible), CRH078 R = 1 (antenna not wholly visible), Tier 42 R = 1 (antenna is wholly visible). Modal class: 1
Length/form of the placoid sensillum: 0,25 of the flagellum length (n = 3 antennae, 2 specimens)
Number of coeloconic sensilla: CRH077 R = 8, L = 7; CRH078 R = 7 (region only partly visible), Tier 42 R = 6. Modal class: 7
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back as far or almost as far as the placoid sensillum, ca. 0,25 of the flagellum length (n = 4 antennae, 3 specimens)
Setae T1: 2-2 (CRH019, R), 2-2 (CRH077, L), 1-2 (CRH077, R), 3-1 (CRH078, L), 2-2 (CRH078, R), 3-2 (Tier 42, L), 2-2 (Tier 13, L), 2-2 (Tier 13, R). Average = 2, variance = 0,27.
Ventral rows of setae T2: CRH019: 3-3 (R); CRH077: 5-5 (L), 5-4 (R); CRH078: 3-4 (L), 4-4 (R); Tier 42: 4-4 (L); Tier 13: 5-5 (L), 4-5 (R). Average = 4,19; variance = 0,56. Hard to say anything about correlation with population or sex or left-right-asymmetry; high variability is obvious.
Scales on unguitractor: 3-4-3 (CRH019, R), 3-3-3 (CRH078, L), 3-3-3 (Tier 13, L)
Integumental glands, inner elements number: Average number of inner elements: 3 (determined from several pictures; the exact number is not always clear, since the elements may have projections that could be counted as separate elements in pictures with poorer magnification)
Integumental glands, outer (or non-differentiated) elements average number: CRH077 18 L Paranotum: 45x2, 5x3. CRH078 15 L Tegmen außen: 17x2, 1x3. Tier 42 24 L Paranotum: 7x2, 3x3. Tier 42 45: 9x2, 5x3. Average = 2.
Integumental glands, longest outer element: 9-11 µm (n = 5)
Integumental glands, density. CRH077 H wilsoni 25 L Tegmen außen: 103 glands

Notes: Tier 42 H wilsoni 37 and CRH019_49 – pictures where secretion leaking from gland can be seen.
In *H. wilsoni* population differences in the number of tibial spurs possible; also variation in seta numbers on T1 and T2 are quite high.

Idophysa chonos (n=1)

Specimen analyzed
Tier 46 W I chonos 05.02.2014, Bryos-mix gesiebt, Brücke 2, Chiloe, Region X, Los Lagos, Chile (abdominal tergites prepared and analyzed dorsally)

Characters
1. *Tibial spurs presence*: yes (very small)
3. *Tibial spurs number/position*: 2 really small spines on the outer side (HR); 1 very small on the outer surface of HL
7. *Form T1*: broadly rounded
26. *Microtrichia on membranous area*: n/a
27. *Form of the flagellum (caudal view)*: ventral margin convex, without constriction defining the tip (1 antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (1 antenna)
29. *Scales on the flagellum petiolus*: very weak to absent (1 antenna)

30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: not reaching apical third (although the only available antenna is partly obscured by secretion, so it is not completely certain)
36. *The genal area under the antennae flat/concave in the middle*: flat (not quite, but concavity seems irregular, shallow and is different in form from Australian species (n = 2 cases, 1 specimen)
37. *Microtrichia medially on genal area absent/present*: present (n = 2 cases, 1 specimen)
38. *Punctation on genal area present/absent*: absent (n = 2 cases, 1 specimen)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 2 cases, 1 specimen)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 2)
41. *First abdominal tergite*: n/a
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: large (> 10 μm) (n = 1)
44. *Microtrichia arrangements*: single, large, in some cases with several points reminding of very tightly grouped microtrichia (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 1)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture abundant on veins as well as on membranes (n = 1)
51. *Ventral sculpture on tegmina, ScP*: sculpture present on most part of the vein (n = 1)
52. *Ventral sculpture on tegmina anteromedially of R and M*: present on the most part of the tegmen, not only posterolaterally of R and M (n = 1)
53. *Ventral sculpture on tegmina, clavus*: present on clavus (n = 1)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with normal sculpture (n = 1)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 1)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 1)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 1)
59. *Ventral sculpture on tegmina, scales*: absent (n = 1)
60. *Ventral sculpture on tegmina, pegs*: present (n = 1)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 1)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: ventral side of the tegmen is uniformly covered with pegs (n = 1)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 1)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 1)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 1)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle.
72. *Integumental glands, orifice*: sunk-in.
73. *Integumental glands, inner elements relative size*. Inner elements much smaller than outer elements
74. *Integumental glands, outer elements*. Not clubbed
75. *Integumental glands, outer elements on dif. body regions.* Outer elements number does not vary with body region
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions
77. *Integumental glands, individual variation*. n/a
78. *Integumental glands on abdominal terga*. Absent
79. *Integumental glands, under plastron.* n/a

80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous (not well visible)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: L = 2 (antenna partly covered by secretion) (1 antenna). Modal class: 2
Length/form of the placoid sensillum: not visible (1 antenna)
Number of coeloconic sensilla: only 3 pores can be seen, but the region is not well visible (1 antenna). Modal class: 3
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): not visible (1 antenna)
Setae T1: 2-2 (both legs). Average = 2, variance = 0.
Ventral rows of setae T2: 3-4 (R), 5-3 (L) Average = 3,8; variance = 0,9.
Scales on unguitractor: n/a
Integumental glands, inner elements number. Average number of inner elements: 2
Integumental glands, outer (or non-differentiated) elements average number. Tier 46 _23 Paranotum: 4x2, 8x3, 1x4. Tier 46_27 Abdomen: 1x2, 3x3, 3x4. Average: 3
Integumental glands, longest outer element. 6-7 µm
Integumental glands, density. Tier 46 I chonos 41: 39 glands

Note: Outer elements 2-4 in number, clearly varying in size (mostly there are 2 elements up to 9 µm long and 1-2 that are much shorter); the longest elements tend to lie flat on the substrate.

Oiophysa ablusa

Specimens analyzed
CRH044, M, Sylvester lake's track, 29.03.2010, from *Dicranoloma robustum*; or 01.04.2010, from *Leucobryum candidum*
CRH097, M, 29.03.2010, Sylvester lake's track, from *Dicranoloma robustum*
CRH098, M, 01.04.2010, Sylvester lake's track, from *Leucobryum candidum* (analyzed dorsally)
(all specimens from Kahurangi National Park, South Island, New Zealand)

Characters
1. *Tibial spurs presence*: no
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n = 5)
26. *Microtrichia on membranous area*: yes (n = 2)
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 2 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 2 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 2 antennae, 2 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third /attaining its apical third (ventral view)*: reaching beyond apical third (n = 1)
36. *The genal area under the antennae flat/concave in the middle*: the region is covered by secretion in both available specimens, but it appears flat in them

37. *Microtrichia medially on genal area absent/present*: the region is covered by secretion in both available specimens, but microtrichia seem to cover all of it
38. *Punctation on genal area present/absent*: present (n = 3 cases, 2 specimens)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 3 cases, 2 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (3 cases, 2 specimens)
41. *First abdominal tergite*: broad and short (410 µm width / 90 µm length (= 4,6); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture present on veins as well as on membranes, but s. the character 52 (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: laterally of M the sculpture is abundant, medially of it is becomes more sparse and confined to the veins (n = 3)
53. *Ventral sculpture on tegmina, clavus*: n/a
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture present between ScA and ScP and on costal cells (several small pegs arranged in a form of a scale) (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: present (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: veins carry broad pegs, whereas membranes carry scales that are sometimes dissipated into several pegs forming together one scale-like assemblage (n = 3)
65. *Dorsal sculpture on tegmina, microtrichia*: present on costal cells and the two branches of Sc (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: quite large, in groups of 2-4, sparse
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements not differentiated into inner/outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (n = 3)
73. *Integumental glands, inner elements relative size*. n/a
74. *Integumental glands, outer elements*. Not clubbed (n = 3)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 3)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 3)
77. *Integumental glands, individual variation*. No individual variation found (n = 3).
78. *Integumental glands on abdominal terga.* Present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga different in structure from glands elsewhere on the body (e.g. in the tergal glands an outer sclerotized ring is present) (n = 1)

92. *Labium tip, coeloconic sensillum*: coeloconic, large pore

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH097 L = 2 (the region is not completely visible). Modal class: 2
Length/form of the placoid sensillum: 0,17 of the flagellum length, not reaching far back along the dorsal margin (n =1)
Number of coeloconic sensilla: CRH097 L = 8, CRH098 R = 2 (the region only partly visible). Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back ca. as far as the placoid sensillum, ca. 0,17 of the flagellum length (n = 1)
Setae T1: 2-2 in four legs, 2-3 in CRH097 L. Average = 2,1; variance = 0,1.
Ventral rows of setae T2: CRH044: 4-3 (L), 4-4 (R); CRH097: 4-5 (R), CRH098: 3-4 (R), 3-4 (L). Average = 3,8; variance = 0,4. No obvious left-right asymmetry.
Scales on unguitractor: 3-3-3 (n=2 legs, 2 specimens)
Integumental glands, inner elements number. n/a
Integumental glands, outer (or non-differentiated) elements average number. CRH044_24 R Paranotum: 7x3, 1x4. CRH097_40 L Paranotum: 4x3, 1x5. CRH097_44 Abdomenende: 5x3, 1x4, 2x5. CRH098_18 Pronotum zentral: 4x3. Average = 3.
Integumental glands, longest outer element. 3 µm (n = 3)
Integumental glands, density. CRH044 O ablusa 34 L Tegmen außen: 56 glands

Note: initially the peripheral elements of integumental glands were considered differentiated into inner and outer circle, but a thorough comparison with Australian species suggests they are not differentiated.

Oiophysa cumberi

Specimens analzed
CRH016, M, January 2013, coll. G. Gibbs, Otaki Forks, Tararua Forest Park
CRH134, M, 16.04.2010, Hauhungatahi, Tongariro National Park, from *Ptychomnion aciculare, Leucobryum candidum, Echinodium hispidum* and *Camptochaete arbuscula* (analyzed dorsally)
Tier 22, F, January 2013, coll. G. Gibbs, Otaki Forks, Tararua Forest Park
(all specimens from North Island, New Zealand)

Characters
1. *Tibial spurs presence*: no (n = 3 legs, 2 specimens)
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n = 1 specimen, 2 legs)
26. *Microtrichia on membranous area*: yes (n = 1 specimen, 2 legs)
27. *Form of the flagellum (caudal view)*: margin convex, without constriction defining the tip (although in Tier 22 L it almost looks like one) (n = 2 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 3 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: weak and slender, do not touch each other (n = 2 antennae, 2 specimens)

30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 1)
36. *The genal area under the antennae flat/concave in the middle*: flat or almost flat on both sides in CRH016 (antennae removed), although appears more concave in Tier 22 R (antennae intact)
37. *Microtrichia medially on genal area absent/present*: absent (2 cases in 1 specimen available)
38. *Punctation on genal area present/absent*: present (3 cases, 2 specimens)
39. *Microtrichia on genal area covered with wax/not*: no wax on both sides of CRH016 (antennae removed), region not well visible in other specimens
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (4 cases, 2 specimens)
41. *First abdominal tergite*: broad and short (390 µm width / 90 µm length (= 4,3); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture present on veins as well as on membranes (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is somewhat poor medially, but not at the extent as in *O. ablusa* (n = 3)
53. *Ventral sculpture on tegmina, clavus*: absent (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 2), but in CRH134 it is absent
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture present between ScA and ScP and on costal cells (several small pegs assembled in round groups) (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: present (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: veins carry short scales, whereas membranes mostly carry small pegs that are mostly grouped in circular assemblages, and sometimes carry normal broad scales (n = 3)
65. *Dorsal sculpture on tegmina, microtrichia*: present on costal cells and the two branches of Sc (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: quite small, in groups of up to dozen or more, dense
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (compared with H. leai or *H. wilsoni*, the elements in *O. cumberi* seem to be more sunk-in, but not always – maybe this character is not so sharply differentiated) (n = 3)
73. *Integumental glands, inner elements relative size*. Inner elements much smaller than the outer elements (n = 3)
74. *Integumental glands, outer elements*. Not clubbed (n = 3)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 3)

76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 3)
77. *Integumental glands, individual variation*. No individual variation found (n = 3).
78. *Integumental glands on abdominal terga*. Present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga similar in structure to glands elsewhere on the body (only the peripheral elements are much shorter) (n = 1)
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: Tier 22 R = 3 (not in a single row), L = 3 (region only partly visible). Modal class: 3
Length/form of the placoid sensillum: 0,17 of the flagellum length, not reaching far back along the dorsal margin (n =2 antennae, 2 specimens)
Number of coeloconic sensilla: 6 (antenna is partly covered by secretion). Modal class: 5
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrated on the tip, stretch back ca. 0,11-0,13 of the flagellum length (n = 2 antennae, 2 specimens)
Setae T1: CRH134: 2-2 (L), 3-2 (R). Average = 2,25; variance = 0,25.
Ventral rows of setae T2: CRH134: 4-6 (L), 5-6 (R). Average = 5,25; variance = 0,92.
Scales on unguitractor: 3-3-3 (n= 1 specimen, 2 legs)
Number of coeloconic sensilla: CRH134 = 5; Tier 22 R = 5 (antenna is partly covered by secretion)
Integumental glands, inner elements number. Average number of inner elements: 2 (there are also cases when they cannot be differentiated; there is apparently a continuous transition between the states “no differentiation into inner/outer elements” and “elements are differentiated”) (n = 3)
Integumental glands, outer (or non-differentiated) elements average number. Tier 22_28 Abdomenende: 3x3, 4x4. Tier 22_31 Abdomenende 1x3, 3x4, 1x5. CRH016_28 Kopf: 5x3, 4x4. CRH016_29 Paranotum: 3x3, 4x4, 1x5. CRH016_32 Abdomen: 2x2, 2x3, 5x4, 3x5. Average: 4.
Integumental glands, longest outer element. 4-6 µm (n = 3)
Integumental glands, density. CRH016_26 O cumberi L Tegmen außen: 60 glands

Oiophysa distincta

Specimens analyzed
CRH101, M, 10.03. 2010, Deadman’s track 2, Fiordland National Park, from *Dendrohypopterygium filiculiforme* (analyzed dorsally)
Tier 9, F, 16.03.2010, Matheson 1, Lake Matheson, Tai Poutini National Park, from *Dendrohypopterygium filiculiforme*
Tier 44, M, 16.03.2010, Matheson 1, Lake Matheson, Tai Poutini National Park, from *Dendrohypopterygium filiculiforme*
(all specimens from South Island, New Zealand)

Characters
1. *Tibial spurs presence*: no (n = 3 specimens, 5 legs)
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n = 4 legs, 3 specimens)
26. *Microtrichia on membranous area*: yes (n = 1)

27. *Form of the flagellum (caudal view)*: ventral margin straight or even somewhat concave on the most part, but slightly convex in the beginning of the apical third; without constriction defining the tip (n = 3 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 4 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: broad, touching each other (n = 2 antennae, 2 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaining apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (n = 3 cases, 2 specimens), although slightly concave in Tier 44 L
37. *Microtrichia medially on genal area absent/present*: present (n = 1 case with antenna removed and 2 cases from 2 specimens with antennae intact)
38. *Punctation on genal area present/absent*: present (n = 1 case with antenna removed and 2 cases from 2 specimens with antennae intact)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 1 case with antenna removed and 2 cases from 2 specimens with antennae intact)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 1 case with antenna removed and 2 case from 2 specimens with antennae intact)
41. *First abdominal tergite*: broad and short (460 µm width / 140 µm length (= 3,3); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 2)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture present on veins as well as on membranes (n = 2)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is present almost everywhere, except on clavus, most part of basal radial cell and adjacent part of the next medial cell (n = 2)
53. *Ventral sculpture on tegmina, clavus*: absent (n = 2)
54. *Ventral sculpture on tegmina, M + CuA*: sculpture absent on M + CuA (n = 2)
55. *Ventral sculpture on tegmina, CuP*: sculpture absent on CuP (n = 2)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 2)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture present between ScA and ScP (several small pegs assembled in round groups) (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 2)
60. *Ventral sculpture on tegmina, pegs*: present (n = 2)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 2)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: veins carry short scales (or broad pegs?), whereas membranes mostly carry small pegs that are mostly grouped in round assemblages, and also carry normal broad scales (n = 2)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 2)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 2)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 2)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 2)
72. *Integumental glands, orifice*. Not sunk-in (n = 2)

73. *Integumental glands, inner elements relative size*. Inner elements much smaller than the outer elements (n = 2)
74. *Integumental glands, outer elements*. Not clubbed (n = 2)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 2)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 2)
77. *Integumental glands, individual variation*. No individual variation found (n = 2)
78. *Integumental glands on abdominal terga*. Present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga similar in structure to glands elsewhere on the body (n = 1)
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: Tier 9 L = 3 (more or less one row), Tier 44 L = 2 (the region is only partly visible), Modal class: 3.
Length/form of the placoid sensillum: 0,11-15 of the flagellum length, not reaching far back along the dorsal margin (n = 2 antennae, 2 specimens)
Number of coeloconic sensilla: CRH101 L = 6, R = 5; Tier 44 L = 7. Median: 6
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrated to the tip, ca. 0,11-0,17 of the flagellum length (n = 3 antennae, 2 specimens)
Setae T1: 2-2 in 3 legs, 3-2 in Tier 9, L. Average = 2,13; variance = 0,13.
Ventral rows of setae T2: CRH101: 4-5 (L), 4-4 (R); Tier 44: 5-5 (R); Tier 9: 5-6 (L). Average = 4,75; variance = 0,5. Hard to say anything about left-right asymmetry. CRH101 is the only specimen from Fiordland NP (all others from Tai Poutini NP) and has less setae – but the sampling is too poor to be sure about anything.
Scales on unguitractor: 3-3-3 (n= 2 legs of different specimens)
Integumental glands, inner elements number. Average number of inner elements: 3
Integumental glands, outer (or non-differentiated) elements average number. CRH101_10 L Paranotum: 7x4, 1x5, 1x6. CRH101_19 L Kopfseite: 1x3, 8x4, 2x5. CRH101_22 Pronotum: 5x4, 2x5. Tier44_27 Abdomenende: 5x3, 7x4. Average: 4.
Integumental glands, longest outer element. 3-4 µm (n = 2)
Integumental glands, density. CRH101 O distincta 40 R Tegmen außen: 40 glands

Pantinia darwini

Specimens analyzed
CRH048, M, 03.02.2014, Cucao Tepual 1, Cucao, Parque nacional Chiloe, from *Arbusculohypopterygium arbuscula* growing on soil & logs
CRH049, F, 03.02.2014, Cucao Tepual 1, Cucao, Parque nacional Chiloe, from *Arbusculohypopterygium arbuscula* growing on soil & logs
CRH050, M, 03.02.2014, Cucao Tepual 1, Cucao, Parque nacional Chiloe, from *Plagiochila rubescens* and *P. hookeriana* growing on soil & logs
Tier 41, F, 07.02.14, Cucao Tepual 2, Cucao, Parque nacional Chiloe, from unspecified bryophytes (analyzed dorsally)

(all specimens from Chiloe, region X, Los Lagos, Chile)

Characters

1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 4 specimens, 8 legs). In two cases (CRH049, R; Tier 41, L) the innermost of the two outermost spines is shifted to the ventral one and is closer to it – both animals are females, the other two are males.
7. *Form T1*: tapered (n = 7)
26. *Microtrichia on membranous area*: yes (n = 4)
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 4 antennae, 3 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: not one row, no furrow (n = 7 antennae, 4 specimens)
29. *Scales on the flagellum petiolus*: very small, not touching each other (n = 4 antennae, 4 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 3 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave (n = 3 cases in 2 specimens with antennae detached, 1 case with intact antennae showing similar condition)
37. *Microtrichia medially on genal area absent/present*: present (n = 3 cases in 2 specimens with antennae detached, 1 case with intact antennae showing similar condition)
38. *Punctation on genal area present/absent*: absent (n = 3 cases in 2 specimens with antennae detached, 1 case with intact antennae showing similar condition)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 3 cases in 2 specimens with antennae detached, 1 case with intact antennae showing similar condition)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 3 cases in 2 specimens with antennae detached, 1 case with intact antennae showing similar condition)
41. *First abdominal tergite*: narrow and long (240 µm width / 160 µm length (= 1,5); n = 1)
42. *Plastron*: lateral regions of anterior and posterior segment borders are plastron-free (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, arranged in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: tend to be arranges in circles (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 4)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: sculpture present on veins as well as on membranes, although on membranes it is often quite sparse (n = 4)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent (n = 4)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 4)
53. *Ventral sculpture on tegmina, clavus*: mostly absent (n = 4)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 4)
55. *Ventral sculpture on tegmina, CuP*: CuP with reduced sculpture (n = 4)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 4)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 4)
59. *Ventral sculpture on tegmina, scales*: present (n = 4)
60. *Ventral sculpture on tegmina, pegs*: present (n = 4)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 4)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: membranes carry interspacing scales and pegs, whereas veins carry only pegs and often are almost bare of sculpture (n = 4)

65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 4)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 4)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 4)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 4)
72. *Integumental glands, orifice*. Sunk-in (n = 4)
73. *Integumental glands, inner elements relative size*. Relative size of inner elements: not significantly smaller than outer elements (n = 4)
74. *Integumental glands, outer elements*. Not clubbed (n = 4)
75. *Integumental glands, outer elements on dif. body regions.* Outer elements number does not vary with body region (n = 4)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 4)
77. *Integumental glands, individual variation*. No individual variation found (n = 4).
78. *Integumental glands on abdominal terga*. Present (n = 1)
79. *Integumental glands, under plastron*. Absent (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga similar in structure to glands elsewhere on the body (n = 1)
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous (CRH048 R – relief for a larger pore?)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum. CRH048 L (detached) = 4, not in a single row; CRH049 L = 2 (antenna is partly covered by secretion); CRH050 L = 4 (the region is not completely visible), R = 3 (the region is only partly visible and covered by secretion); Tier 41 R = 4 (antenna partly covered by secretion). Modal class: 4.
Length/form of the placoid sensillum: 0,27-0,4 of the flagellum length (n = 4 antennae, 3 specimens)
Number of coeloconic sensilla: CRH049 L = 6, R = 7; CRH050 L = 7, R = 7, Tier 41 R = 7. Modal class: 7
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back, but not as far as the placoid sensillum, ca. 0,2-0,25 of the flagellum length (n = 5 antennae, 3 specimens)
Setae T1: CRH048: 3-2 (L), 3-4 (R); CRH049: 4-3 (R), 3-4 (L); CRH050: 2-3 (R), 3-2 (L); Tier 41: 2-2 (L), 1-2 (R). In contrast to all other analyzed species, the setae seem to have no order, they mostly do not even form a line as they normally do. Average = 2,69; variance = 0,76. Host plant differences cannot be inferred, all specimens are from roughly the same population (not more than 100 meters distance between collection sites), no obvious differences between sexes (2 males and 2 females studied).
Ventral rows of setae T2: CRH048 2-4 (L), 4-4 (R); CRH049: 3-4 (R), 5-3 (L); CRH050: 4-4 (R), 4-3 (L); Tier 41: 5-4 (L), 3-3 (R). Average = 3,69; variance = 0,63. Host plant differences cannot be inferred, all specimens are from roughly the same population (not more than 100 meters distance between collection sites), no obvious differences between sexes (2 males and 2 females studied).
Scales on unguitractor: 3-3-3 (2 specimens, 3 legs)
Integumental glands, inner elements number. Average number of inner elements: 4 (n = 4)
Integumental glands, outer (or non-differentiated) elements average number. CRH048_42 R Paranotum: 8x2, 7x3, 2x4. CRH048_60 L Tegmen: 9x2, 12x3, 2x4. CRH049_26 R Paranotum: 1x2, 10x3, 4x4. CRH050_47 R Tegmen: 3x3, 5x4. Tier 41_12 R Kopfseite: 1x2, 3x3. Average = 3
Integumental glands, longest outer element. 4-6 µm (n = 4)
Integumental glands, density. CRH049 P darwini 47 L Tegmen außen: 76 glands

Note: *Pantinia darwini* seems to vary more than any other species in the number of setae on T2 and especially T1. Also, the setae on T1 seem not so orderly as in other species.

Peloridium hammoniorum

Specimens analyzed

CRH054, F, 02.02.2014, Senda 1, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
CRH055, F, 02.02.2014, Senda 1, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
CRH056, M, 02.02.2014, Senda 1, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
CRH066, M, 02.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus* (analyzed dorsally)
Tier 10, M, 02.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus* (analyzed dorsally)
Tier 27, M, 02.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
Tier 28, F, 02.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
Tier 31, M, 07.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
Tier 32, F, 02.02.2014, Makropter, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Polytrichadelphus magellanus*
(all specimens from Chiloe, Region X, Los Lagos, Chile)

Characters

1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, symmetrical (n = 7 specimens, 11 legs)
7. *Form T1*: tapered (n = 5 specimens, 7 legs), in Tier 31 it looks more like broadly rounded.
26. *Microtrichia on membranous area*: yes (n = 2); same in fore- and middle legs available
27. *Form of the flagellum (caudal view)*: ventral margin convex, without constriction defining the tip (n = 1 antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: one row, with furrow (n = 6 antennae, 4 specimens)
29. *Scales on the flagellum petiolus*: broad, almost touch each other (n = 5 antennae, 5 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaining apical third (n = 5 antennae, 5 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave in the middle (n = 6 cases in 6 specimens with antennae removed)
37. *Microtrichia medially on genal area absent/present*: present (n = 6 cases in 6 specimens with antennae removed)
38. *Punctation on genal area present/absent*: absent (n = 6 cases in 6 specimens with antennae removed), although the vertex and upper ridge are punctated
39. *Microtrichia on genal area covered with wax/not*: covered with wax (n = 6 cases in 6 specimens with antennae removed)
40. *Posterior ridge of genal area under the antennae convex and reflexed/not*: reflexed and convex (n = 6 cases in 6 specimens with antennae removed)

41. *First abdominal tergite*: narrow and long (350/200 µm width/length in CRH066 (1,8); 346/153 µm width/length (= 2,3); n = 2)
42. *Plastron*: present on the whole of abdominal dorsum (n = 2)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 2)
44. *Microtrichia arrangements*: single, differently sized, arranged in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: sparse pegs are present only on basal subcostal cells and the basal radial cell (n = 5)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: n/a
51. *Ventral sculpture on tegmina, ScP*: sculpture absent on most of the veins length, present only basally (n = 7)
52. *Ventral sculpture on tegmina anteromedially of R and M*: n/a
53. *Ventral sculpture on tegmina, clavus*: n/a
54. *Ventral sculpture on tegmina, M + CuA*: n/a
55. *Ventral sculpture on tegmina, CuP*: n/a
56. *Ventral sculpture on tegmina, apical radial cell*: n/a
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 4)
59. *Ventral sculpture on tegmina, scales*: absent (n = 5)
60. *Ventral sculpture on tegmina, pegs*: present (n = 5)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 5)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: some membranes carry some sparse sculpturing of pegs, whereas veins are bare (n = 5)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 6)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 6)
68. *Dorsal sculpture on tegmina, punctation*: absent (n = 7)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements can be divided into outer and inner circle (n = 8)
72. *Integumental glands, orifice*. Not sunk-in (n = 8), although on thorax and head almost the whole gland in sunk-in into cuticula
73. *Integumental glands, inner elements relative size.* Inner elements not significantly smaller than outer elements (n = 8)
74. *Integumental glands, outer elements*. Not clubbed (n = 8)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 8)
76. *Integumental glands on head and pronotum*. Glands on head and thorax are sunk-in into the cuticula (n = 8)
77. *Integumental glands, individual variation.* No individual variation found (n = 8)
78. *Integumental glands on abdominal terga*: present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga different to glands elsewhere (outer elements are absent, but a cuticular ring aroung the gland is present) (n = 1)
92. *Labium tip, coeloconic sensillum*: probably socketed, not well visible (CRH056 R)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH055 R = 4 (not in one row), Tier 27 L = 4 (not in one row), Tier 28 L = 5 (not in one row), Tier 31 L = 3 (partly covered by secretion; not in one row), Tier 32 R = 5 (not in one row). Modal class: 4-5.
Length/form of the placoid sensillum: ca. 0,4 of the flagellum length (n = 1)
Number of coeloconic sensilla: Tier 27 L = 7, R = 7; Tier 28 L = 8, R = 8; Tier 31 L = 8. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back, not as far as the placoid sensillum, ca. 0,27 of the flagellum length (n = 1); 3 more specimens where exact measurement was not made have similar length
Setae T1: CRH055: 2-2 (R); CRH056: 2-3 (R), 3-2 (L); CRH066: 2-3 (L); Tier 27: 3-3 (L), 3-2 (R); Tier 28: 3-3 (R); Tier 31: 3-2 (L), 2-2 (R); Tier 32: 3-3 (L), 3-3 (R). Average = 2,59; variance = 0,25. No obvious differences between sexes or left-right asymmetry; all animals from the same population and host plant.
Ventral rows of setae T2: CRH055: 6-6 (R); CRH056: 6-6 (R), 6-6 (L); Tier 27: 6-6 (L), 5-7 (R); Tier 28: 6-6 (R); Tier 31: 6-5 (L), 6-5 (R); Tier 32: 6-6 (L). Average = 5,89; variance = 0,22. No obvious differences between sexes or left-right asymmetry; all animals from the same population and host plant.
Scales on unguitractor: 5-5-4 (n= 1, CRH055) (4-3-4 in one foreleg of CRH054, 3-4-4 in another, 4-5-4 in a foreleg of CRH055, 5-5-4 in a middle leg of CRH055, 4-4-4 in a middle leg of CRH066)
Integumental glands, inner elements number. Average number of inner elements: 4 (n = 8)
Integumental glands, outer (or non-differentiated) elements average number. CRH054_18 R Paranotum: 1x3, 6x4. CRH066_29 L Paranotum: 3x2, 3x3, 4x4. Tier 27_23 Paranotum: 2x3, 9x4. Tier 27_63 Abdomen: 3x2, 2x4, 2x5. Tier 32_14 L Paranotum: 9x2, 3x3. Average = 3
Integumental glands, longest outer element. 2-3 µm (n = 8)
Integumental glands, density. Tier 27 P hammoniorum 55 L Tegmen außen: 13 glands

Larvae (10 analyzed, instars 1st to 5th, of each instar one specimen analyzed ventrally and one dorsally): integumental glands are small knobs (ca. 7-8 µm diameter), in older instars inner and outer elements can be distinguished. The subapical opening has the form of a zigzag in younger larvae, in older instars the angles of the zigzag become inner elements (3-5 in number), spine- or peg-like. Outer elements are mostly 2, seldom 3 or 4 in number (the additional elements are always smaller than the two common elements). Outer elements grow with the animal, being under 1 µm in 1st instar larvae and achieving ca. 4 µm in older ones.

Notes: Glands on head and thorax are more sunk-in into the channel opening (sometimes not only the inner peripheral elements but even the outer ones) than those on membranous areas (tegmina, paranotal cells).

Peloridium pomponorum

Specimens analyzed
CRH051, F, 26.01.2014, Pichihuillilemu, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Sphagnum falcatulum*
CRH052, F, 26.01.2014, Pichihuillilemu, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Sphagnum falcatulum*
CRH053, M, 26.01.2014, Pichihuillilemu, Estacion Biologica „Senda Darwin“, Ancud, Chiloe, from *Sphagnum falcatulum*
CRH057, F, 05.02.2014, track between localities Rancho Grande 1 and 2, Parque Nacional de Chiloe, from *Sphagnum capillifolium*, *S. falcatulum* and *S. magellanicum*

CRH058, F, 05.02.2014, track between localities Rancho Grande 1 and 2, Parque Nacional de Chiloe, from *Sphagnum capillifolium*, *S. falcatulum* and *S. magellanicum*
CRH059, M, 05.02.2014, track between localities Rancho Grande 1 and 2, Parque Nacional de Chiloe, from *Sphagnum capillifolium*, *S. falcatulum* and *S. magellanicum*
CRH070, F, 28.01.14, Tepual 2, Estacion Biologica „Senda Darwin", Ancud, Chiloe, from *Sphagnum fimbriatum* (analyzed dorsally)
Tier 33, M, 03.02.2014, Lahuan, Parque Nacional de Chiloe, from *Sphagnum falcatulum*
Tier 34, F, 03.02.2014, Lahuan, Parque Nacional de Chiloe, from *Sphagnum falcatulum*
(all specimens from Chiloe, Region X, Los Lagos, Chile)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, symmetrical (n = 8 specimens, 12 legs), but CRH051 (L) – the inner ventral spine is absent, CRH058 – the outer ventral spine is absent (here no correlation with sex, population or host plant obvious)
7. *Form T1*: tapered (n = 8 legs)
26. *Microtrichia on membranous area*: yes (n= 4 specimens, 6 legs)
27. *Form of the flagellum (caudal view)*: ventral margin convex, without constriction defining the tip (1 antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: furrow and single row (n = 4 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: broad, touch each other (n = 8 antennae, 8 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaining apical third (n = 5 antennae, 5 specimens; in CRH059 they seem to reach only the middle of the flagellum)
36. *The genal area under the antennae flat/concave in the middle*: concave (n = 5 cases in 5 specimens)
37. *Microtrichia medially on genal area absent/present*: present (n = 5 cases in 5 specimens)
38. *Punctation on genal area present/absent*: absent (n = 5 cases in 5 specimens)
39. *Microtrichia on genal area covered with wax/not*: covered with wax (n = 5 cases in 5 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: convex and reflexed to variable degree (n = 5 cases in 5 specimens)
41. *First abdominal tergite*: narrow and long (380 µm width / 170 µm length (= 2,2); n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: single, arranged in rows (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: sparse pegs are present only on basal subcostal cells (n = 4)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: n/a
51. *Ventral sculpture on tegmina, ScP*: sculpture absent on most of the veins length, present only basally (n = 7)
52. *Ventral sculpture on tegmina anteromedially of R and M*: n/a
53. *Ventral sculpture on tegmina, clavus*: n/a
54. *Ventral sculpture on tegmina, M + CuA*: n/a
55. *Ventral sculpture on tegmina, CuP*: n/a
56. *Ventral sculpture on tegmina, apical radial cell*: n/a
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 5)
59. *Ventral sculpture on tegmina, scales*: absent (n = 4)

60. *Ventral sculpture on tegmina, pegs*: present (n = 4)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 4)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: some membranes carry some sparse sculpturing of pegs, whereas veins are bare (n = 4)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 7)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 7)
68. *Dorsal sculpture on tegmina, punctation*: absent (n = 7)
71. *Integumental glands, peripheral elements differentiation.* Peripheral elements differentiated into inner and outer circle (n = 8)
72. *Integumental glands, orifice*. Not sunk-in (n = 8), except for glands on thorax and head that are sunk-in as a whole.
73. *Integumental glands, inner elements relative size*. Inner elements not significantly smaller than outer elements (n = 8)
74. *Integumental glands, outer elements*. Not clubbed (n = 8)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 8)
76. *Integumental glands on head and pronotum*. Glands on head and thorax are sunk-in into the cuticula (n = 8)
77. *Integumental glands, individual variation*. No individual variation (n = 8)
78. *Integumental glands on abdominal terga*. Present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga are similar in structure to glands elsewhere on the body, although in some specimens the glands under plastron did look differently.
92. *Labium tip, coeloconic sensillum*: socketed, large pore (CRH052 L, CRH057 R); Tier 33 multiporous?

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH051 R = 6 (not in one row); CRH052 L = 6 (not in one row); CRH053 L = 3 (in one row; the region is partly covered by secretion), CRH059 = 5 (not in one row, the region is partly covered by secretion); Tier 33 R = 5 (not in one row); Tier 34 L = 4 (not in one row, region is partly covered by secretion). Modal class: 5 or 6.
Length/form of the placoid sensillum: ca. 0,4 of the flagellum length (n = 2 antennae, 2 specimens), with a broadening on its basal end (CRH070 L)
Number of coeloconic sensilla: CRH070 R = 8 (the region only partly visible), L = 9; Tier 34 L = 8 (rest of the specimens is too contaminated). Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back in an almost straight line, not quite as far as the placoid sensillum, ca. 0,3 of the flagellum length (n = 2 antennae, 1 specimen)
Setae T1: CRH051: 2-2 (L); CRH052: 2-3 (R), 2-2 (L); CRH053: 3-2 (L), 2-3 (R); CRH057: 2-2 (L); CRH058: 2-4 (R), 2-2 (L); CRH070: 3-2 (L); Tier 33: 3-2 (L); Tier 34: 2-1 (L) (in the last case not quite sure). Average = 2,27; variance = 0,4. No obvious differences between sexes, populations, host plants (several different *Sphagnum* species) or left-right asymmetry.
Ventral rows of setae T2: CRH051: 4-5 (L); CRH052: 4-4 (R), 4-4 (L); CRH053: 5-4 (L), 4-5 (R); CRH057: 5-5 (L); CRH058: 5-4 (R), 4-4 (L); CRH070: 4-4 (L); Tier 33: 4-4 (L); Tier 34: 5-4 (L) (in the last case not quite sure). Average = 4,32; variance = 0,23. No obvious differences between sexes, populations, host plants (several different *Sphagnum* species) or left-right asymmetry.

Scales on unguitractor: 4-4-4 (in both legs of CRH051), 5-5-5 (CRH052, R), 6-5-5 (CRH052, L); 5-4-5 (CRH057, L). CRH051 and CRH052 are of the same population, host plant and sex (female).
Integumental glands, inner elements number. Average number of inner elements: 5 (n = 8)
Integumental glands, outer (or non-differentiated) elements average number. CRH051_09 Abdomenende: 5x2. CRH052_37 L Kopf: 2x2, 2x3. CRH057_33 L Kopf: 4x2, 5x3. Tier 33_17 L Paranotum: 1x2, 4x3, 2x4, 1x5. Tier 33_34: 1x2, 4x3, 7x4. Average = 3.
Integumental glands, longest outer element. 2 µm (n = 8)
Integumental glands, density. CRH058_P pomponorum 37 R Tegmen außen: 23 glands

Larvae (4 specimens analyzed, 4th and 5th instars, of each instar one specimen studied dorsally and one ventrally): structure of integumental glands is basically the same as in *P. hammoniorum.*

Notes: Glands on head and thorax are more sunk-in into the channel opening (sometimes not only the inner peripheral elements but even the outer ones) than those on membranous areas (tegmina, paranotal cells).

Like in *H. wilsoni*, individual variation in *P. pomponorum* in tibial spur numbers is present, but not attributable to population differences as in the other species.

Peloridora holdgatei

Specimens analyzed
CRH045, M, 03.02.2014, Cucao Tepual 1, Cucao, Parque nacional Chiloe, from *Plagiochila rubescens* and *P. hookeriana* growing on soil & logs
CRH046, F, 05.02.2014, Rancho Grande 1, Parque nacional Chiloe, from unspecified bryophytes (abdomen in this specimen was dissected from the body and studied dorsally)
CRH047, F, 05.02.2014, Rancho Grande 1, Parque nacional Chiloe, from unspecified bryophytes
Specimen without number, F, Rancho Grande 2. (or 2. Bridge), Parque nacional Chiloe, from unspecified bryophytes
(all specimens from Chiloe, Region X, Los Lagos, Chile)

Characters
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, the outer two grouped together (n = 3 specimens, 6 legs)
7. *Form T1*: tapered (n = 4)
26. *Microtrichia on membranous area*: no (n = 3)
27. *Form of the flagellum (caudal view)*: ventral margin convex, without constriction defining the tip (n = 3 antennae, 3 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not one row (n = 5 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: slender, not touching each other (n = 3 antennae, 3 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 3 antennae, 3 specimens), although in CRH046 L the folds in surface structure remind of scales (like in *H. echina*)
36. *The genal area under the antennae flat/concave in the middle*: concave (in CRH045 L with detached antenna and CRH045 R, 047 R and L with intact antenna)
37. *Microtrichia medially on genal area absent/present*: present (CRH045 L with detached antenna and both sides of CRH047 with antenna intact)

38. *Punctation on genal area present/absent*: absent in the only specimen (CRH045 L) where the region is well visible, although there are punctures on vertex
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 1 case with detached antenna and 1 with antenna intact)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (4 cases in 2 specimens)
41. *First abdominal tergite*: n/a
42. *Plastron*: lateral regions of anterior and posterior segment borders are free of plastron (n = 2)
43. *Plastron-building microtrichia*: small (2-3 μm) (n = 2)
44. *Microtrichia arrangements*: single microtrichia predominate laterally, whereas those in the middle are mostly grouped (n = 2)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 2)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture present on most of the veins length (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 3)
53. *Ventral sculpture on tegmina, clavus*: present on the most part (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with normal sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 2)
59. *Ventral sculpture on tegmina, scales*: absent (n = 3)
60. *Ventral sculpture on tegmina, pegs*: present (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same (n = 3)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 2)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (n = 4)
72. *Integumental glands, orifice*. Sunk-in (n = 4)
73. *Integumental glands, inner elements relative size*. Relative size of inner elements: not significantly smaller than outer elements (n = 4)
74. *Integumental glands, outer elements*. Not clubbed (n = 4)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 4)
76. *Integumental glands on head and pronotum*. Glands on head and thorax not different to those on other body regions (n = 4)
77. *Integumental glands, individual variation*. No individual variation found (n = 4)
78. *Integumental glands on abdominal terga*. Present (on regions not covered with plastron) (n = 2)
79. *Integumental glands, under plastron*: Absent (n = 2)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga similar in structure to glands elsewhere on the body (n = 2)
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Chacarters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH045 R = 1, CRH046 L = 3 (all on top, antenna is partly obscured by secretion), CRH047 R = 2. Median: 2.
Length/form of the placoid sensillum: ca. 0,3 of the flagellum length (n = 3 antennae, 2 specimens)
Number of coeloconic sensilla: CRH045 R = 5 (antennae partly covered by secretion); CRH046 R = 7, L = 7; CRH047 L = 8, R = 8. Modal class: 7-8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back, not as far as the placoid sensillum, ca. 0,22-0,27 of the flagellum length
Setae T1: 2-2 (n = 3 specimens, 6 legs). Average = 2; variance = 0. Absolutely no differences between sexes, populations, host plants (only in once case the exact host plant species was known) or left-right asymmetry.
Ventral rows of setae T2: 3-3 (n = 3 specimens, 6 legs). Average = 3; variance = 0. Absolutely no differences between sexes, populations, host plants (only in once case the exact host plant species was known) or left-right asymmetry.
Scales on unguitractor: 3-3-3 (n = 1); the form of the scales might be interesting (the only peloridiid species where lateral rows of scales are shifted mediad and distance between the scales of the median row is increased; also the form is distinctly different from other species (more V-like, not spade-like)
Integumental glands, inner elements number. Average number of inner elements: 2 (n = 4)
Integumental glands, outer (or non-differentiated) elements average number. CRH045_22 Abdomenende: 13x2, 5x3. CRH046_37 R Paranotum: 9x2, 13x3, 1x4. CRG047_23 L Paranotum: 2x2, 4x3, 2x4. CRH047_29 Abdomenende: 2x2, 3x3, 1x4. Stefan_04: 4x2, 3x3, 5x4. Average: 3.
Integumental glands, longest outer element. 6-8 µm (n = 4)
Integumental glands, density. CRH045 P holdgatei 35 R Tegmen außen = 65 glands

Xenophyes cascus: n = 12 (specimens; in two of them both hind legs were studied, so for tarsal characters n = 14).

Specimens analyzed
CRH014, M, 09-11.04.2010, Otaki forks, Tararua Forest Park, from unspecified bryophytes
CRH021, M, 06.04.2010, Orongorongo, Rimutaka Forest Park, from *Plagiochila stephensoniana* and *Ptychomnion aciculare* (abdomen in this specimen was dissected from the body and studied dorsally)
CRH022, M, 06.04.2010, Orongorongo, Rimutaka Forest Park, from *Plagiochila stephensoniana* and *Ptychomnion aciculare* (analyzed dorsally)
CRH023, F, 06.04.2010, Orongorongo, Rimutaka Forest Park, from *Plagiochila stephensoniana* and *Ptychomnion aciculare*
CRH024, M, 09-11.04.2010, Otaki forks, Tararua Forest Park, from unspecified bryophytes
CRH025, M, 09-11.04.2010, Otaki forks, Tararua Forest Park, from unspecified bryophytes
Tier 4, M, 12.04.10, Otaki forks, Tararua Forest Park, from *Racopilum convolutaceum*
Tier 12, M, 14.04.2010, Dawson falls, Taranaki National Park, from *Leucobryum candidum* and *Dicranoloma sp*.
Tier 14, F, 06.04.2010, Orongorongo 2, Rimutaka Forest Park, from *Dicranoloma dicarpum*
Tier 15, M, 06.04.2010, Orongorongo 2, Rimutaka Forest Park, from *Dicranoloma billarderi*
Tier 16, F, 14.04.2010, Dawson falls, Taranaki National Park, from *Leucobryum candidum* and *Dicranoloma sp*.
Tier 17, M, 16.04.2010, Hauhungatahi, Tongariro National Park, from *Ptychomnion aciculare*, *Leucobryum candidum* and *Echinodium hispidum*

Tier 18, F, 17.04.2010, Mangawhero walk 2, Tongariro National Park, from *Dendrohypopterygium filiculiforme*
8 more specimens of both sexes from Otaki forks (a male and a female was pre-treated with dishwashing detergent, gasoline, chloroform and ethylacetate, respectively), coll. 2012 by George Gibbs – in most of those eight the abdomen was dissected and studied dorsally.
(all specimens from North Island, New Zealand)

Characters
1. *Tibial spurs presence*: no
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n = 10)
26. *Microtrichia on membranous area*: no (n = 5) – although present in a foreleg in Tier 17!
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 2 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 9 antennae, 8 specimens)
29. *Scales on the flagellum petiolus*: slender, not touching each other (CRH021 L) to broad, almost touch each other (CRH024 L and Tier 15 L)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 6 antennae, 6 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (4 cases in 4 specimens with detached antennae, supported by 3 cases in 3 specimens with antennae intact)
37. *Microtrichia medially on genal area absent/present*: in CRH014 L cover almost the whole area, in CRH021 R the region is almost bare (sparse sculpturing closer to the eye), in Tier 16 and 18 somewhat intermediate condition. Condition in Tier 15 is very similar to CRH021; both animals are from the same population (Orongorongo)
38. *Punctation on genal area present/absent*: absent (4 cases in 4 specimens with detached antennae)
39. *Microtrichia on genal area covered with wax/not*: no wax (4 cases in 4 specimens with detached antennae)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed (4 cases in 4 specimens with detached antennae)
41. *First abdominal tergite*: broad and short (375 µm width / 100 µm length (= 3,8) in CRH022; n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 7, excluding the two specimens that were dewaxed with chloroform)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 9)
44. *Microtrichia arrangements*: single, differently sized, mostly in rows, but not always (n = 9)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 10)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 13)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 13)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 12)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 13)
53. *Ventral sculpture on tegmina, clavus*: present on the most part (n = 13)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with normal sculpture (n = 13)
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 13)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 13)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 10)

59. *Ventral sculpture on tegmina, scales*: present (n = 13)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 13)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 13)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same and consists of scales that sometimes may be smaller on veins (n = 13)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 16)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 16)
68. *Dorsal sculpture on tegmina, punctation*: limited to the stem of R and AP (n = 16)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated into inner and outer circle (although here as in some other speices these differentiation is probably not absolute, e.g. the case where all peripheral elements are gouped in one single volute - CRH022_X cascus 10 R Paranotum). (n = 13)
72. *Integumental glands, orifice*. Not sunk-in (n = 13)
73. *Integumental glands, inner elements relative size*. Not significantly smaller than outer elements (n = 13)
74. *Integumental glands, outer elements*. Not clubbed (n = 13)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 13)
76. *Integumental glands on head and pronotum*. Glands on head and thorax are located both dorsally and ventrally on elevations of cuticula (n = 13)
77. *Integumental glands, individual variation*. No individual variation found (n = 13)
78. *Integumental glands on abdominal terga*. Present (n = 1)
79. *Integumental glands, under plastron*. Present (n = 1)
80. *Integumental glands on abdominal terga, similarity*. Glands on abdominal terga similar in structure to the glands elsewhere on the body (n = 1) However, in the 2 specimens dewaxed with chloroform they look quite differently, but this might be an artefact.
92. *Labium tip, coeloconic sensillum*: coeloconic, large pore (CRH014 R, CRH021 R, CRH022 L, CRH024 L – although here more pores could be present, TEST Spüli L)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH014 = 3 (partly covered by secretion, in one row), CRH021 L = 2 (partly covered by secretion); CRH023 R = 4 (almost in one row); CRH024 L = 2 (partly covered by secretion); Tier 4 L = 3 (one row), Tier 14 R = 4; Tier 15 L = 3. Modal class: 3
Length/form of the placoid sensillum: ca. 0,13 (measurable only in one case, and here the region may not be completely visible) of the flagellum not reaching far back along the dorsal margin (but the region is not completely visible in all 6 cases; n = 6 antennae, 6 specimens)
Number of coeloconic sensilla: CRH014 L = 6; CRH024 L = 6; CRH025 L = 7, R = 6 (region only partly visible); TEST Ether R = 6; TEST Spüli R = 5 (the antenna is partly covered by secretion). Modal class: 6
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrated on the tip, ca. 0,16 of the flagellum length (n = 1, but the 5 cases where exact measurement was not made have a similar arrangement)
Setae T1: 13 with 2, 1 with 3 pairs. Average = 2,1; variance = 0,1. No differences between sexes, populations, host plants or left-right asymmetry.
Ventral rows of setae T2: CRH021: 4-4 (L); CRH022: 4-4 (L); CRH023: 4-4 (R), CRH024: 5-5 (L), CRH025: 6-5 (R); TEST Benzin: 5-4 (L); TEST Spüli M: 4-5 (R); TEST Spüli W: 5-4 (R); Tier 17: 6-6 (L); Tier 4: 5-4 (L); Tier 14: 4-5 (L); Tier 15: 5-4 (L); Tier 16: 6-5 (L); CRH014: 5-4 (R). No obvious correlation to sex or

population; Tier 16 (Dawson falls) and 17 (Hauhungatahi) have more setae than others, but it is hard to attribute that to specific host plants, since in each case the specimen was taken from a mixture of 2 or 3 different host plant species. No right-left asymmetry. Average = 4,7; variance = 0,5.
Scales on unguitractor: 3-3-3 (n = 4 legs, 4 specimens)
Integumental glands, inner elements number. Average: 5 (n = 13)
Integumental glands, outer (or non-differentiated) elements average number. CRH014_26 R Kopfvorderrand: 1x2, 3x3. CRH021_26 L Paranotum: 5x3, 1x4, 3x5. TEST Benzin 0108: 2x3, 1x4, 1x6. Average = 4
Integumental glands, longest outer element. 1 µm (n = 13)
Integumental glands, density. CRH014_35 X cascus R Tegmen außen: 30 glands

Larvae (6 studied, 3rd to 5th instars, one specimen dorsally and one ventrally of each instar): the glands are small knobs (ca. 7-8 µm in diameter) with a slit-like opening on one side, close to the base; the opening is covered from above by 3-5 (mostly 4) peripheral elements, all of similar size, under 1 µm.

Notes: Peripheral elements are not easy to differentiate (secretion may obscure the picture).
Outer elements of glands on head and paranota stand on a circular elevation surrounding the opening with the inner elements, whereas glands on other body regions are flatter (= have no such elevation).

Xenophyes kinlochensis

Specimens analyzed
CRH108, F, 08.03.2010, Key Summit track, Fiordland National Park, from *Ptychomnion aciculare* growing on logs and soil (analyzed dorsally)
Tier 19, F, 06.03.2010, Key Summit, Fiordland National Park, from *Chandonanthus squarrosus*
Tier 20, F, 06.03.2010, Key Summit, Fiordland National Park, from *Chandonanthus squarrosus*
Tier 21, M, 06.03.2010, Key Summit, Fiordland National Park, from *Sphagnum cristatum*
Specimen without number, M, 08.03.2010, Key Summit track, Fiordland National Park, from *Plagiochila circinalis*
(all specimens from South Island, New Zealand)

Characters
1. *Tibial spurs presence*: no (n = 5)
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n = 10)
26. *Microtrichia on membranous area*: no (n = 1)
27. *Form of the flagellum*: ventral margin straight, without constriction defining the tip (n = 4 antennae, 2 specimens)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 5 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: slender and not touching each other (w/o number, L) to broad, almost touching each other (w/o number R and Tier 19 L)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: not reaching apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: concave (only closer to the base of the antenna - Tier 19 R, Tier 21 R, numberless specimen R; or overall – Tier 20 R and L)

37. *Microtrichia medially on genal area absent/present*: present (in 5 cases of 4 specimens with antennae detached)
38. *Punctation on genal area present/absent*: present (in 5 cases of 4 specimens with antennae detached)
39. *Microtrichia on genal area covered with wax/not*: no wax (in 5 cases of 4 specimens with antennae detached)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (in 5 cases of 4 specimens with antennae detached)
41. *First abdominal tergite*: broad and short (500 µm width / 120 µm length (= 4,2) n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 2)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 2)
44. *Microtrichia arrangements*: single, differently sized, not in rows (n = 2)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 2)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent on most of the veins length (n = 3), although sculpture is present on the medial side of the vein
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 3)
53. *Ventral sculpture on tegmina, clavus*: present on the most part (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3)
55. *Ventral sculpture on tegmina, CuP*: CuP with somewhat reduced, but still visible sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same and consists of scales that sometimes may be somewhat smaller on veins (n = 3)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 3)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: limited to the stem of R and AP (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements differentiated in inner and outer circle (n = 4)
72. *Integumental glands, orifice*. Not sunk-in (n = 4)
73. *Integumental glands, inner elements relative size*. Not significantly different in size from outer elements (n = 4)
74. *Integumental glands, outer elements*. Not clubbed (n = 4)
75. *Integumental glands, outer elements on dif. body regions.* Outer elements number does not vary with body region (n = 4)
76. *Integumental glands on head and pronotum.* Glands on head and thorax are not different to those on other body regions (n = 4)
77. *Integumental glands, individual variation*. No individual variation found (n = 4)
78. *Integumental glands on abdominal terga.* Present (n = 2)
79. *Integumental glands, under plastron*. Present (n = 2)
80. *Integumental glands on abdominal terga, similarity.* Glands on abdominal terga different in structure from glands elsewhere on the body (n = 2)

92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous (but with a large pore too in the specimen w/o number?)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: without number L = 2 (region only partly seen); Tier 18 L = 3 (region only partly seen). Modal class: 2-3
Length/form of the placoid sensillum (caudal view): ca. 0,25 of the flagellum length (n = 2 antennae, 2 specimens)
Number of coeloconic sensilla: w/o number L = 6 (the antennae is partly covered by secretion), R = 6 (the antennae is quite strongly covered by secretion); CRH108 L = 6 (+ 1 sensillum very far away), R = 6. Modal class: 6
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): stretch back, ca. 0,2-0,26 of the flagellum length (n = 3 antennae, 2 specimens)
Setae T1: 2 pairs (n=5). Average = 2; variance = 0. No differences between sexes, populations, host plants or left-right asymmetry.
Ventral rows of setae T2: CRH108: 5-5 (L), Tier 20: 5-4 (L); w/o number: 5-5 (L), 6-4 (R). Average = 4,88; variance = 0,41. No obvious differences between sexes, populations, host plants or left-right asymmetry.
Scales on unguitractor: 3 rows (n = 1)
Integumental glands, inner elements number. Average number of inner elements: 4 (n = 4)
Integumental glands, outer (or non-differentiated) elements average number. CRH108_21 R Kopfseite: 1x6, 1x7, 3x8, 1x9. CRH108_23 R Pronotum: 1x6, 3x7, 2x8. CRH108_25 Pronotum: 1x6, 3x7, 4x8, 4x9, 1x10. w/o number_22 R Paranotum: 2x6, 1x7, 1x8, 1x9. w/o number 40 L Kopfseite: 2x6, 2x7, 2x8. w/o number _64 R Tegmen außen: 1x4, 4x5, 2x6, 1x7. Average = 7
Integumental glands, longest outer element. 2-3 µm (n = 4)
Integumental glands, density. Tier-19-22 X kinlochensis L Tegmen außen: 94 glands

Xenophyes rhachilophus

Specimens analyzed
002024, M, 04.03.2010, Tutoko valley, Fiordland National Park, from *Bazzania adnexa*, *Leucobryum candidum* and *Wijkia extenuata*
002032, F, 04.03.2010, Tutoko valley, Fiordland National Park, from *Bazzania adnexa*, *Leucobryum candidum* and *Wijkia extenuata*
CRH012, M, 04.03.2010, Tutoko valley, Fiordland National Park, from *Bazzania adnexa*, *Leucobryum candidum* and *Wijkia extenuata*
CRH013, M, 04.03.2010, Tutoko valley, Fiordland National Park, from *Bazzania adnexa*, *Leucobryum candidum* and *Wijkia extenuata*
CRH032, M, 04.03.2010, Tutoko valley, Fiordland National Park, from *Leucobryum candidum* and *Wijkia extenuata* (abdomen in this specimen was dissected and studied dorsally)
CRH034, F, 04.03.2010, Tutoko valley, Fiordland National Park, from *Leucobryum candidum* and *Wijkia extenuata*
CRH036, F, 07.03.2010, Hollyford valley, Fiordland National Park, from *Dendrohypopterygium filiculiforme*

CRH040, F, 10.03.2010, Hollyford valley, Fiordland National Park, from *Dendrohypopterygium filiculiforme* (analyzed dorsally)
(all specimens from South Island, New Zealand)

Characters
1. *Tibial spurs presence*: no (n=6)
3. *Tibial spurs number/position*: n/a
7. *Form T1*: broadly rounded (n=6)
26. *Microtrichia on membranous area*: no
27. *Form of the flagellum (caudal view)*: ventral margin straight, without constriction defining the tip (n = 1, CRH036, L antenna)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 3 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: slender, not touching each other
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaing apical third (although both specimens that were analyzed have distorted antennae which may bias the view; n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (n = 8 cases in 6 specimens), although in CRH013 R slightly concave
37. *Microtrichia medially on genal area absent/present*: present (n = 5 cases in 4 specimens with antennae detached)
38. *Punctation on genal area present/absent*: present (n = 2 cases in 2 specimens, in the rest the region around the eye, where the punctation is normally present, is covered by secretion)
39. *Microtrichia on genal area covered with wax/not*: no wax (n = 4 cases in 4 specimens)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (n = 8 cases in 6 specimens)
41. *First abdominal tergite*: broad and short (410 µm width / 100 µm length (= 4,1) n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 2)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 2)
44. *Microtrichia arrangements*: single, differently sized, mostly not arranged in groups (n = 2)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 2)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 6)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 6)
51. *Ventral sculpture on tegmina, ScP*: sculpture present (n = 7)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 6)
53. *Ventral sculpture on tegmina, clavus*: present on the most part (n = 6)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 6)
55. *Ventral sculpture on tegmina, CuP*: CuP with reduced sculpture (n = 6)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 6)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture present between ScA/ScP and sometimes on the basalmost costal cell; solitary small pegs (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 6)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 6)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 6)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same and consists of scales that sometimes may be somewhat smaller on veins (n = 6)
65. *Dorsal sculpture on tegmina, microtrichia*: present on the cell between ScA and ScP (n = 5)

66. *Dorsal sculpture on tegmina, microtrichia features*: solitary small pegs (n = 5)
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 6)
68. *Dorsal sculpture on tegmina, punctation*: limited to the stem of R and AP (n = 7)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elements are differentiated into inner and outer circle (n = 8)
72. *Integumental glands, orifice*. Not sunk-in (n = 8)
73. *Integumental glands, inner elements relative size.* Not significantly smaller than outer elements (n = 8)
74. *Integumental glands, outer elements*. Not clubbed (n = 8)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 8)
76. *Integumental glands on head and pronotum.* Glands on head and thorax are located on elevations of cuticula (n = 8)
77. *Integumental glands, individual variation.* No individual variation found (n = 8)
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron.* n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, large pore (002032 L, CRH032 R, CRH036 R and L)

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: 002024 R = 5 (not in a single row); 02032 L = 5 (not in single row; the region is only partly visible); CRH036 L = 4 (not in single row; the region is for the most part covered by secretion). Modal class: 5
Length/form of the placoid sensillum: ca. 0,1 of the flagellum length (n = 1, CRH036, L antenna)
Number of coeloconic sensilla: CRH036 L = 6 (+ 1 further back); 002024 R = 6; 002032 L = 6. Modal class: 6
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrating on the tip, ca. 0,16 of the flagellum length (n = 1, but 2 more cases where exact measurement was not made have a similar arrangement)
Setae T1: 2 pairs in all (n=7), except 1 specimen with 3 setae on one side and 2 on the other. Average = 2,06; variance = 0,06. No obvious differences between sexes, populations, host plants or left-right asymmetry.
Ventral rows of setae T2: CRH012: 5-5 (L); CRH013: 5-6 (R); CRH032: 5-6 (L); CRH036: 6-6 (R); CRH040: 5-4 (L); 002024: 5-4 (L); 002032: 5-5 (L). Average = 5,14; variance = 0,44. 6 pairs in both rows are in the only specimen in the study from Hollyford valley; the rest coming from Tutoko valley or Deadman's track (which is very close to Hollyford valley) and showing quite high variation as well, and also both populations are not very far away from each other – so, most likely, no populational differences here. No obvious differences between sexes and host plants or left-right asymmetry.
Scales on unguitractor: single unguitractor could be partly seen (in one lateral row 2, in the middle 2, in another lateral row 4 scales (CRH013, HR). On fore and middle legs (n=4) the number is variable – in one case the middle row has 4, in other 3 scales; the lateral rows always seem to have 3)
Integumental glands, inner elements number. Average number of inner elements: 3 (n = 8)
Integumental glands, outer (or non-differentiated) elements average number. 002024_12 R Paranotum: 4x2, 7x3. 002024_31 R Tegmen: 1x2, 6x3, 2x4, 1x5. CRH013_28 R O-Detail: 2x2, 4x3. CRH013_39 R Tegmen innen: 7x3, 5x4. CRH034_29 R Tegmen: 2x2, 3x3, 4x4, 1x5. Average: 3
Integumental glands, longest outer element. 2-3 µm (n = 8)
Integumental glands, density. 002032_X rhachilophus 38 R Tegmen außen: 52 glands

Larvae (one 5th instar speimen studied ventrally): the glands are small knobs (ca. 7-8 µm) with a slit-like opening on one side, close to the ground, flanked the peripheral elements of ca. 2 µm length, sometimes with a much smaller (under 1 µm) element between them. The opening is usually well visible.

Notes: Outer elements of glands on head and paranota stand on a circular elevation surrounding the opening with the inner elements, whereas glands on other body regions are flatter (= have no such elevation).

Xenophysella greensladeae

Specimens analyzed
CRH043, M, 16.03.2010, Matheson 1, lake Matheson, Tai Poutini National Park, from *Schistochila appendiculata*
CRH095, M, 16.03.2010, Matheson 1, lake Matheson, Tai Poutini National Park, from *Plagiochila gigantea*
CRH096, M, 16.03.2010, Matheson 1, lake Matheson, Tai Poutini National Park, from *Schistochila appendiculata* (analyzed dorsally)
(all specimens from South Island, New Zealand)

Characters
1. *Tibial spurs presence*: yes (n = 2 legs of 1 specimen + 2 more specimens with 1 leg each, seen only partly but not demonstrating differences)
3. *Tibial spurs number/position*: 4, symmetrical
7. *Form T1*: broadly rounded (n = 1)
26. *Microtrichia on membranous area*: the region is not available to inspection on hind legs, but microtrichia are absent from 2 forelegs where the region is open to observation
27. *Form of the flagellum (caudal view)*: ventral margin convex, with constriction in apical third defining the tip (n = 2 antennae, 1 specimen)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 4 antennae, 2 specimens)
29. *Scales on the flagellum petiolus*: broad, touch each other (n = 2 antennae, 2 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaining apical third (n = 2 antennae, 2 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (2 cases in 2 specimens, partly visible due to intact antennae)
37. *Microtrichia medially on genal area absent/present*: present (although in the 2 cases available (2 specimens) the region is not completely visible due to intact antennae)
38. *Punctation on genal area present/absent*: present (2 cases in 2 specimens, but the region is only partly visible due to intact antennae)
39. *Microtrichia on genal area covered with wax/not*: no wax (2 cases in 2 specimens, partly visible due to intact antennae)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed (2 cases in 2 specimens, only partly visible due to intact antennae)
41. *First abdominal tergite*: broad and short (360 µm width / 100 µm length (= 3,6) n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: mostly grouped, especially in the middle of the segment (n = 1)

45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 3)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 3)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent (n = 3)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 3)
53. *Ventral sculpture on tegmina, clavus*: present (n = 3)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with reduced sculpture (n = 3), although in two specimens (CRH096, CRH043) still the vein bears sculpture on half of its length
55. *Ventral sculpture on tegmina, CuP*: CuP with reduced sculpture (n = 3)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 3)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 3)
59. *Ventral sculpture on tegmina, scales*: present (n = 3)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 3)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 3)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same and consists of scales that sometimes may be somewhat smaller on veins (n = 3)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 1; other two specimens were too tightly covered with dirt)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 3)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 3)
71. *Integumental glands, peripheral elements differentiation*. Peripheral elemets differentiated into inner and outer circle (n = 3)
72. *Integumental glands, orifice*. Not sunk-in (n = 3)
73. *Integumental glands, inner elements relative size.* Relative size of inner elements: significantly smaller than outer elements (n = 3)
74. *Integumental glands, outer elements*. Not clubbed (n = 3)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 3)
76. *Integumental glands on head and pronotum.* Glands on dorsal side of head and thorax are located on elevations of cuticula (n = 3)
77. *Integumental glands, individual variation*. No individual variation found (n = 3)
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79. *Integumental glands, under plastron.* n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: CRH043 R = 2; CRH095 = 1 (the rest of the antennae is obscured by secretion). Modal class: 1-2
Length/form of the placoid sensillum: ca. 0,05 of the flagellum length (n = 2 antenna, 1 specimen); seems to be concentrated to the very tip (at least no dorsal extension is visible in caudal view)
Number of coeloconic sensilla: CRH043 L = 8, R = 7; CRH095 L = 8, R = 8. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrated on the tip, ca. 0,13-0,16 of the flagellum length (n = 2 antennae, 1 specimen)

Setae T1: 2 pairs in one case and 3 on one side and 2 on the other in another case (n = 2 legs of 1 specimen). Average = 2,25; variance = 0,25. Nothing can be said about differences between sexes, populations or host plants since the characters could only be studied on one specimen.
Ventral rows of setae T2: 4-4 (L), 4-5 (R). Average = 4,25; variance = 0,25. (n = 2 legs of 1 specimen). Nothing can be said about differences between sexes, populations or host plants since the characters could only be studied on one specimen.
Scales on unguitractor: not available, seen only partly in one case; 3 scales in all 3 rows on one foreleg available
Integumental glands, inner elements number. Average number of inner elements: 5 (n = 3)
Integumental glands, outer (or non-differentiated) elements average number. CRH043_32 L Paranotum: 4x4, 5x5, 5x6, 2x7. CRH095_23 R Paranotum: 4x1, 2x5, 1x6, 2x7, 2x8. CRH095_47 L Tegmen außen: 5x4, 7x5. CRH096_48 R Kopfseite: 2x4, 2x5, 3x6, 4x7. Average: 5
Integumental glands, longest outer element. 3-4 µm (n = 3)
Integumental glands, density. CRH043_X greensladeae 44 R Tegmen außen: 50 glands

Notes: Glands dorsally on pronotum and head tend to be located not in cuticular depressions as usual, but on cuticular elevations.

Xenophysella stewartensis

Specimens analyzed:
CRH011, M, 13.02., 16.02. and 17.02.2010, Horseshoe Bay 1, Ulva 1, Ulva 3, from *Bazzania adnexa* and *Dicranoloma billardieri*
CRH112, M, 13.02.2010, Horseshoe Bay 1, from *Schistochila lehmanniana* (analyzed dorsally)
Tier 8, M, 13.02., 16.02. and 17.02.2010, Horseshoe Bay 1, Ulva 1, Ulva 3, from *Bazzania adnexa* and *Dicranoloma billardieri*
Tier 23, M, Stewart Island
Tier 39, F, 13.02., 16.02. and 17.02.2010, Horseshoe Bay 1, Ulva 1, Ulva 3, from *Bazzania adnexa* and *Dicranoloma billardieri*
(all specimens from Stewart Island, New Zealand)

Characters:
1. *Tibial spurs presence*: yes
3. *Tibial spurs number/position*: 4, symmetrical (n = 5 specimens with 8 legs)
7. *Form T1*: rounded
26. *Microtrichia on membranous area*: absent in one case (CRH011, HR) and present in another (Tier 39, HL) – although here it is only a single one and not well visible, so "microtrichia absent" is taken as the character state here
27. *Form of the flagellum (caudal view)*: ventral margin convex, with constriction in apical third defining the tip (n = 2 antennae, 1 specimen)
28. *Furrow bordering the placoid sensillum and pores in one row/no furrow, not a single row*: no furrow, not a single row (n = 5 antennae, 3 specimens)
29. *Scales on the flagellum petiolus*: broad, touch each other (n = 5 antennae, 4 specimens)
30. *Scales on the fusiform flagellum not reaching its apical third/attaining its apical third (ventral view)*: attaining apical third (n = 3 antennae, 3 specimens)
36. *The genal area under the antennae flat/concave in the middle*: flat (2 cases in 1 specimen with anternnae detached and 2 cases in 1 specimen with intact antennae)
37. *Microtrichia medially on genal area absent/present*: present (2 cases in 1 specimen with antennae detached and 2 cases in 1 specimen with intact antennae)

38. *Punctation on genal area present/absent*: present (2 cases in 1 specimen with antennae detached and 1 case in 1 specimen with intact antennae)
39. *Microtrichia on genal area covered with wax/not*: no wax (2 cases in 1 specimen with antennae detached and 1 case in 1 specimen with intact antennae)
40. *Posterior ridge of genal area under the antennae convex and reflexed /not*: not reflexed or convex (2 cases in 1 specimen with antennae detached and 2 cases in 1 specimen with intact antennae)
41. *First abdominal tergite*: broad and short (350 µm width / 110 µm length (= 3,2) n = 1)
42. *Plastron*: present on the whole of abdominal dorsum (n = 1)
43. *Plastron-building microtrichia*: small (2-3 µm) (n = 1)
44. *Microtrichia arrangements*: mostly grouped, especially in the middle of the segment (n = 1)
45. *Microtrichia on lateral regions of abdominal tergites*: unorganized (n = 1)
49. *Sculpture on ventral surface of the tegmina*: covers large areas of the surface (n = 4)
50. *Ventral sculpture on tegmina, presence veins vs. membranes*: uniform sculpture present on veins as well as on membranes (n = 4)
51. *Ventral sculpture on tegmina, ScP*: sculpture absent (n = 4)
52. *Ventral sculpture on tegmina anteromedially of R and M*: sculpture is abundant almost everywhere on the ventral surface (n = 4)
53. *Ventral sculpture on tegmina, clavus*: present (n = 4)
54. *Ventral sculpture on tegmina, M + CuA*: M + CuA with normal sculpture (n = 4), although in two specimens (CRH011, CRH112) it is somewhat reduced
55. *Ventral sculpture on tegmina, CuP*: CuP with normal sculpture (n = 4)
56. *Ventral sculpture on tegmina, apical radial cell*: bare spot is absent (n = 4)
57. *Ventral sculpture on tegmina, bare spot on the apical radial cell*: n/a
58. *Ventral sculpture on tegmina, between ScA/ScP and/or on costal cells*: sculpture absent (n = 4)
59. *Ventral sculpture on tegmina, scales*: present (n = 4)
60. *Ventral sculpture on tegmina, pegs*: absent (n = 4)
62. *Ventral sculpture on tegmina, "compressed scales"*: absent (n = 4)
64. *Ventral sculpture on tegmina, character veins vs. membranes*: sculpture on veins and membranes is the same and consists of scales that sometimes may be somewhat smaller on veins (n = 4)
65. *Dorsal sculpture on tegmina, microtrichia*: absent (n = 2; other two specimens were too contaminated)
66. *Dorsal sculpture on tegmina, microtrichia features*: n/a
67. *Dorsal sculpture on tegmina, trichoid sensilla*: present on veins (n = 4)
68. *Dorsal sculpture on tegmina, punctation*: widespread (n = 4)
71. *Integumental glands, peripheral elements differentiation.* Peripheral elements differentiated into inner and outer circle (n = 5)
72. *Integumental glands, orifice*. Not sunk-in (n = 5)
73. *Integumental glands, inner elements relative size*. Relative size of inner elements: significantly smaller than outer elements (n = 5)
74. *Integumental glands, outer elements*. Not clubbed (n = 5)
75. *Integumental glands, outer elements on dif. body regions*. Outer elements number does not vary with body region (n = 5)
76. *Integumental glands on head and pronotum*. Glands on head and thorax are not different to those on other body regions (n = 5)
77. *Integumental glands, individual variation*. No individual variation found (n = 5)
78. *Integumental glands on abdominal terga*. Absent (n = 1)
79 *Integumental glands, under plastron.* n/a
80. *Integumental glands on abdominal terga, similarity*. n/a
92. *Labium tip, coeloconic sensillum*: coeloconic, multiporous

Characters not used in the matrix:

Number/position of setae on the ventral surface of the flagellum: Tier 8 L = 2, R = 2; Tier 23 R = 3 (not in one row); Tier 39 L = 2 (the antenna is partly obscured by secretion). Modal class: 2
Length/form of the placoid sensillum: ca. 0,05 of the flagellum length (n = 2 antennae, 1 specimen); seems to be concentrated on the very tip of the segment
Number of coeloconic sensilla: Tier 23 R = 8, L = 8; Tier 39 L = 6. Modal class: 8
Position of coeloconic sensilla on the flagellum (concentrated on the tip/reaching further back): concentrated on the tip, although stretching further back than the placoid sensillum, ca. 0,13-0,16 of the flagellum length (n = 2 antennae, 1 specimen)
Setae T1: CRH011: 2-2 (R), 2-2 (L); CRH112: 2-3 (R); Tier 8: 2-2 (R); Tier 23: 2-2 (L), 2-2 (R); Tier 39: 2-2 (R), 2-2 (L). Average = 2,06; variance = 0,06.
Ventral rows of setae T2: CRH011: 4-4 (L), 4-5 (R); CRH112: 5-4 (R); Tier 8: 4-5 (R); Tier 23: 5-4 (L), 4-5 (R); Tier 39: 4-5 (R), 5-4 (L). Average = 4,44; variance = 0,26. No obvious differences between sexes or populations; exact host plants species in most cases unknown. Where right and left legs in one specimen could be compared: no obvious right-left asymmetry.
Scales on unguitractor: 3 scale in all rows (n = 1), also 3 in one foreleg
Integumental glands, inner elements number. Average number of inner elements: 3 (number somewhat uncertain, since only few pictures were available where the inner elements are clearly seen) (n = 5)
Integumental glands, outer (or non-differentiated) elements average number. Tier 23_36: 2x4, 3x5, 2x6. CRH011_28 L Paranotum: 1x3, 6x4, 2x5. CRH112_30 Kopf: 3x4, 1x5, 1x6. Tier39_29 Abdomen: 1x3, 2x5. Average: 5
Integumental glands, longest outer element. 2-4 µm (n = 5)
Integumental glands, density. CRH011_38 X stewartensis R Tegmen außen: 60 glands

Declaration of originality / Eigenständigkeitserklärung

Declaration

I, Viktor Hartung, hereby declare that this thesis has been written by me and that it is the record of work carried out by me without the help of any third parties other than specified. Where other sources of information, data, photos or concepts have directly or indirectly been used, they have been acknowledged.

I, Viktor Hartung, hereby declare that this thesis has not been submitted in the same or any similar form in any application for a higher degree (e.g. PhD) anywhere else.

I, Viktor Hartung, hereby declare that the results of the diploma thesis on Peloridiidae that was made by me, supervised by Prof. Dr. Hoch and submitted on 23.10.2007 were not used in the present study and all the information presented here was obtained after the completion of the diploma thesis.

I, Viktor Hartung, hereby declare that I am aware of the terms and conditions of the doctoral degree regulations that this thesis is subjected to (Mathematisch-Naturwissenschaftliche Fakultät I, Amtliches Mitteilungsblatt der Humboldt-Universität Nr. 33, 2005).

Berlin, 08.01.2018

Erklärung

Hiermit erkläre ich, Viktor Hartung, dass ich die vorliegende Arbeit selbstständig und ohne die unzulässige Hilfe Dritter und ohne die Verwendung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Daten, Bildmaterialien und Konzepte sind unter Angabe der Quelle gekennzeichnet.

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Berlin, den 08. Januar 2018